DOCUMENT RESUME

ED 367 292 IR 016 552

AUTHOR Smith, Irene Elizabeth
TITLE An Investigation into Students' Perceptions of the Learning Environment Provided by Hypermedia Tools in an Interdisciplinary High School Course of Studies.
INSTITUTION International Society for Technology in Education, Eugene, OR.
REPORT NO ISBN-1-56484-046-8
PUB DATE 93
NOTE 240p.; Ph.D. Dissertation, University of Oregon. Cover title varies: "HyperMedia: A Review of the Literature and a Survey of Student Perceptions."
AVAILABLE FROM International Society for Technology in Education, 1787 Agate St., Eugene, OR 97403-1923.
PUB TYPE Dissertations/Theses - Doctoral Dissertations (041) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Academic Achievement; *Computer Assisted Instruction; Computer Software; Creativity; Cultural Education; Educational Environment; High Schools; High School Students; *Hypermedia; Interviews; Learning Motivation; Observation; Perception; Perception Tests; Qualitative Research; Questionnaires; Student Attitudes; *Student Motivation; *Student Reaction; Teacher Attitudes
IDENTIFIERS Empowerment; HyperCard; *Learning Environments

ABSTRACT

This doctoral dissertation reports on a study that investigated the hypermedia learning environment from the perspective of high school students learning about U.S. culture. Qualitative methods were used to determine student perceptions about learning with hypermedia tools. Data were collected from daily observations, interviews, student products, formal and informal discussions, and questionnaires. This daily, 5-month investigation produced data which were subsequently used to analyze student perceptions. The data were classified into a number of categories and the analysis was cross checked. The study concluded that there are a number of student perceptions that are supportive of the use of a hypermedia learning environment. Students indicated that the nature of hypermedia products promoted a feeling of empowerment. Students became experts on certain topics and shared their expertise. The freedom of choice and opportunity to be creative promoted considerable motivation. Hypermedia documents were viewed by students as much more public than traditional work. Producing a hypermedia document promoted understanding at a deeper level than using a traditional assignment. Teachers in this program concurred that learning was enhanced and all participants in the program indicated the use of a hypermedia learning environment to be advantageous. Copies of the questionnaires used are appended. (Contains 96 references.) (Author/TMK)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it

☐ Minor changes have been made to improve reproduction quality

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

A Doctoral Dissertation

ED 367 292

HyperMedia

A Review of the Literature and a Survey of Student Perceptions

Irene E. Smith

"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY D. Moursund

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)"

BEST COPY AVAILABLE

About the Author

Dr. Irene Smith has been an educator at the high school and junior high level for 20 years. She has taught academic mathematics programs, coached a number of varsity sports, and served as a counselor in the public school system in British Columbia.

For the last three years, Irene has been a doctoral student at the University of Oregon. She graduated in June 1993 with a Ph.D. in education. Her dissertation reflects her involvement and interest in hypermedia-based learning. For the last two years, she worked as a technology consultant and teaching assistant for Sheldon High School in Eugene, where she was involved in a program that offered a hypermedia learning experience to high school juniors. She has also served as a technology consultant to the Yujin Gakuen Japanese Immersion School. Students at this school are offered a technology-based curriculum using both English and Japanese languages.

In addition, Irene has taught a number of computer courses in the University of Oregon summer program and has given presentations at national computer conferences. She is currently involved as a consultant to the Independent Studies program offered by the International Society for Technology in Education.

Project Coordinator
Jean Hall

Book Cover
Tamara Kidd

© International Society for Technology in Education, 1993
1787 Agate Street, Eugene, Oregon 97403-1923
Order Desk: 800/336-5191
Phone: 503/346-4414
Fax: 503/346-5890
CompuServe: 70014,2117
Internet: ISTE@ Oregon.uoregon.edu

ISBN 1-56484-046-8

AN INVESTIGATION INTO STUDENTS' PERCEPTIONS OF THE LEARNING ENVIRONMENT PROVIDED BY HYPERMEDIA TOOLS IN AN INTERDISCIPLINARY HIGH SCHOOL COURSE OF STUDIES

by

IRENE ELIZABETH SMITH

A DISSERTATION

Presented to the Division of Teacher Education
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 1993

APPROVED: David Moursund

Dr. David Moursund

©1993 Irene Elizabeth Smith

An Abstract of the Dissertation of

Irene Elizabeth Smith for the degree of Doctor of Philosophy

in the Division of Teacher Education

to be taken June 1993

Title: AN INVESTIGATION INTO STUDENTS' PERCEPTIONS OF THE LEARNING ENVIRONMENT PROVIDED BY HYPERMEDIA TOOLS IN AN INTERDISCIPLINARY HIGH SCHOOL COURSE OF STUDIES

Approved: David Moursund

Dr. David Moursund

To provide optimal learning environments for students, new and innovative programs often involving the use of technology, are being developed. In 1984, a large, urban high school created an integrated, interdisciplinary program to help students develop an understanding of the events which have shaped and influenced United States culture. Beginning in 1990, the program was revised to include a hypermedia learning environment. The students use the hypermedia tools as supplementary resources and learn to create new hypermedia documents. Hypermedia is complex, yet exciting addition to the learning environment. By determining what the students perceived as advantages and disadvantages of using hypermedia learning tools, suggestions can be made for improvement of the use of such tools.

This study investigated the hypermedia learning environment from the perspective of the students learning about United States culture. Qualitative methods were used to determine student perceptions about learning with hypermedia tools. The researcher became a participant observer in the program in a role of lab assistant. Data was collected from daily observations, interviews, student products, formal and informal discussions, and questionnaires. This daily,

five month investigation produced data which has subsequently been used to analyze student perceptions. The data was classified into a number of catagories and the analysis was cross checked using data obtained from the variety of sources previously described.

This study concluded that there are a number of student perceptions that are supportive of the use of a hypermedia learning environment. Students indicated that the nature of hypermedia products promoted a feeling of empowerment. Students became experts on certain topics and shared their expertise. The freedom of choice and opportunity to be creative promoted considerable motivation. Hypermedia documents are viewed by students as much more public than traditional work. As a result, students indicated making considerable effort to produce quality work. Producing a hypermedia document promoted understanding at a deeper level than using a traditional assignment. Teachers in this program concur that learning was enhanced and all participants in the program indicated the use of a hypermedia learning environment to be advantageous.

VITA

NAME OF AUTHOR: Irene Elizabeth Smith

PLACE OF BIRTH: North Pine, British Columbia

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon
Gonzaga University
University of Victoria

DEGREES AWARDED:

Doctor of Philosophy, 1993, University of Oregon
Master of Education, 1989, Gonzaga University
Bachelor of Education, 1965, University of Victoria

AREAS OF SPECIAL INTEREST:

Hypermedia
Desktop Publishing
Computer Education
Mathematics

PROFESSIONAL EXPERIENCE:

Instructor, Learning *HyperCard* and HyperTalk Programming, ISTE Independent Study Course, Eugene, Oregon, 1992-1993.

Instructor, Tools for Teachers, Continuing Education, University of Oregon, Eugene, 1992.

Instructor, State of the Art Software, Continuing Education, University of Oregon, Eugene, 1992.

Instructor, *HyperCard* for Educators, Continuing Education, University of Oregon, Eugene, 1992.

Classroom Instructor, Mathematics Department, Vernon Senior Secondary, Vernon, British Columbia, 1978-1990.

High School Counselor, Counseling Department, Vernon Senior Secondary, Vernon, British Columbia, 1974-1978.

Mathematics and Physical Education Instructor, Pleasant Valley Secondary, Armstrong, British Columbia, 1970-1974.

Lab Assistant, United States Culture Program, Sheldon High School, Eugene, Oregon, 1991-1993.

Technology Assistant, Yujin Gakuen Japanese Immersion School, Eugene, Oregon, 1992-1993.

TABLE OF CONTENTS

Chapter — Page

I. INTRODUCTION 1

Personal Interest in Hypermedia 2
Description of the Research Site 4
Computer Component 5
Description of the ACCESS Hypermedia Application 6
ACCESS Standardized Stack Appearance 8
ACCESS Special Features 10
ACCESS Authoring Features .....
ACCESS Collects Research Data 14
Arguments For and Against Hypermedia 15
Content of the USC program 16
Unit One 17
Unit Two 18
Unit Three 19
USC Curriculum 19
USC Organization 20
Research Questions 21

II. LITERATURE REVIEW 23

Introduction 23
Terminology 23
Features Appropriate for Hypermedia Systems 27
Use of a Metaphor 27
Browsing Tools 29
Navigation Aids and Difficulties 30
Placing and Designing the Links 32
Filters, Indexes, Bookmarks and Note Takers 34
Problem of Cognitive Overhead 36
Communication Processes—Paper and Electronic 38
Communication With Sound and Images 42
Examples of Hypertext Environments 48
Intermedia 48
Guide 51
Project Emperor-I 53
Galileo 55
Reactions to Examples of Hypertext Environments 58
Learning—General Comments 59
Learning with Hypermedia—Special Issues 61
Authoring 61
Collaboration 62
Discovery or Exploratory Learning 64
Ill-Structured Domains of Study 65

Page

Integration of Disciplines 68
Learning Styles 70
HyperCard—the Educators Tool 74
Tentative Answers to Research Questions 77
Summary 80

III. METHODOLOGY 81

Information Collection Design for the Research 81
Overview of Research Instruments 83
Observations 83
Questionnaires 84
Informal Interactions 84
Interview Sessions 85
Documents and Student Products 87
Overview of Data Analysis and Interpretation 88
Interviews 89
Questionnaires 90
Observations 90
Student Products 91
Validity and Reliability 91

IV. DATA PRESENTATION 94

Data Collection Process 94
Background—Research Site And Student Participants 96
Background—Computer Experience Information 96
Background—The Macintosh Lab 103
Background—Student Computer Activities 105
Background—Browsing of Stacks 108
Background—Learning Style 110
Background—Authoring of Stacks 112
Specific Categories Identified In Collected Data 120
Category I—Part One—Providing the Motivation to Learn 120
Motivation—Organization of information 121
Motivation—Graphics 122
Motivation—Novelty of Computers 124
Motivation—Ease of Finding Information 127
Motivation—User Choice and Freedom 128
Category I—Part Two—Factors Limit Motivation to Learn 129
Limits—Design Flaws in the Stacks 129
Limits—Choice of Vocabulary 131
Limits—Resource Restricted to Electronic Presentation 133
Category II—Navigation 134
Navigation—Map Card 135
Navigation—Go Recent Function 136
Navigation—Search Feature 138
Category III—Personal Ownership 140
Personal Ownership—An Example 141
Personal Ownership—Shared Successes 142

Page

Category IV—Interaction Between Authoring and Browsing 144
Browsing and Authoring 144
Category V—Multiple Perspectives and Informal Discussion 148
Category VI—Technology skills 152
Technology Skills—Keyboarding 152
Technology Skills—Graphic Resources 153
Technology Skills—Sound Resources 156
Technology Skills—Networked Computers 159
Technology Skills—Note Taking 159
Technology Skills—Value for Employment 163

V. IMPLICATIONS FROM THE RESEARCH STUDY 165

Discussion of Question 1 166
Question 1a 166
Difficulty with Hypermedia in General 166
Difficulties Specific to the Research Site 167
Question 1b 168
Value of ACCESS Stacks Authored by Teachers 168
Perceived Advantages in Hypermedia Writing 169
Empowerment of Hypermedia 171
Question 1c 172
Question 1d 172
Question 1e 175
Discussion of Question 2 177
Additional Questions Which Emerged During the Study 182
Summary of Research Study and Researcher Recommendations 185
Complexity of Hypermedia 185
Teacher Guidance and Assignment Design 188
Student and Teacher Roles Redefine 189
Communication Skills—Text, Images, and Sound 190
Limitations of the Study 192
Discussion of Japanese Immersion School Versus USC Use of Hypermedia 195
Teacher Commitment to Hypermedia as a Learning Tool 199
Personality of Students Affects the Students Perception of Hypermedia Learning 201
Authoring as a Way to Teach Students to Read Stacks 203
Learning Associations With Hypermedia Tools Versus No Hypermedia 204
Hypermedia Used in Interdisciplinary Programs Versus Traditional Classes 206
Conclusions 207

APPENDIX

A. COMPUTER EXPERIENCE TALLY 210

B. HARLEM RENAISSANCE ASSIGNMENT FOR ACCESS 211

C. REQUIREMENTS OF TERM ONE PROJECT 212

Page

D. QUESTIONNAIRE:TERM PROJECT RESEARCH STACK 214

REFERENCES 215

LIST OF FIGURES

Figure Page

1. Opening Card of ACCESS 7
2. Help Card of ACCESS 9
3. The Authoring Palette in ACCESS 11
4. Creating an ACCESS Stack 12
5. Naming an ACCESS Card 12
6. The Card Title and Count 13
7. ACCESS Journal Entry 15
8. Macintosh Desktop Icons 101
9. Five Card Stack Example—Cards 1-3 106
10. Five Card Stack Example—Cards 4-5 107
11. *Hypercard* Tools, Patterns, and Bucket Tool 113
12. Sample Writing From Access Stack 132
13. Sample Student Map Card 137
14. The Go Recent Window in *Hypercard* 137
15. The Search Dialogue Box 139
16. Note Taking Window in Access 162
17. Student Concept Map 180
18. Student Concept Map 181

LIST OF TABLES

Table Page

1. Computer Experience Tally—Word Processing. 97
2. Number of Word Processors Familiar to Students. 97
3. Student Self-Rating of Computer Competency. 98
4. Student Self-Rating of Frequency of Use. 98
5. Rating of Anticipated Computer Skill Increase by USC Students. 99
6. Home Computer Availability to USC Students. 99
7. Results from Teacher Created Questionnaire 119

CHAPTER I

INTRODUCTION

Hypermedia can be defined as an "information management tool that links text, graphics, sound, or other types of media in an associative way. In doing so, it allows users of a system to navigate through information in a nonlinear fashion" (Bielawski & Lewand, 1991, p. 41). While hypermedia has a long history, it is only in recent years that computer related and other technologies have developed to a level to make hypermedia a practical reality. Use of hypermedia is presently growing quite rapidly in education and other fields.

In 1945 Vannevar Bush, science advisor to United States President Roosevelt, expressed concern about the quantities of information that science research had produced as a result of research efforts during the war.

> There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers—conclusions which he cannot find time to grasp, much less to remember, as they appear. (Bush, 1945, p. 101) . . . A record, if it is to be useful to science, must be continuously extended, it must be stored, and above all it must be consulted. (p. 102)

In an effort to address the problems he foresaw, Bush developed a theoretical machine he called the Memex (Memory Extender). With the aid of a Memex, he felt scientists would be able to store books and writings in a mechanized form to provide speed and flexibility in use. Most importantly, Bush felt that his vision improved on any informational organization format already available.

> The human mind does not work that way [like an index system]. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. It has other characteristics, of course; trails that are not frequently followed are prone to fade, items are not fully permanent, memory is

> transitory. Yet, the speed of action, the intricacy of trails, the detail of mental pictures, is awe-inspiring beyond all else in nature. (Bush, 1945, p. 106)

Bush felt that his machine could be designed to model the working of the human mind. He wanted to have "associative indexing, the basic idea of which is a provision whereby any item may be caused at will to select immediately and automatically another" (p. 107). The technology available to Bush in the 1940's could not achieve the fulfillment of his idea.

Personal Interest in Hypermedia

I first became acquainted with the concept of hypermedia during an introductory course on *HyperCard*, a product I received when I purchased my Macintosh computer in 1990. The assigned readings for the course included some of the classic papers on hypermedia such as Bush, As We May Think, Van Dam, Hypertext '87 Keynote Address, and Conklin, Hypertext: An Introduction and Survey. These works continually appear as references in many of the books and articles that I have consulted in my search for additional information about hypermedia.

As I attempted to learn the skills necessary to create my own *HyperCard* stacks, I found myself struggling to accept the flexibility inherent in this presentation medium. I had considerable difficulty moving beyond the linear presentation—a part of my traditional education—to the nonsequential emphasis of this tool. I learned to create stacks—the hypermedia documents that the *HyperCard* application allows one to produce. I constantly asked myself "How do I know that a person using my stack will receive the message I intended to convey when I created the stack? If the user follows a pathway that varies from what 'I' viewed as optimal, will the message be distorted or lost?"

The question still lingers unanswered, but I realize this has become less and less of a concern to me. By focusing on the question, I have been motivated to undertake many interesting and challenging activities—including this dissertation. Each new effort provides

further information about hypermedia in general and *HyperCard* in particular. I have learned a great deal and have a growing awareness of how relatively little is known about hypermedia in educational settings.

During the last two years, I have had the opportunity to work with *HyperCard* in a variety of situations. I assisted teachers using *HyperCard* and *HyperStudio* with a group of third and fourth grade students. I helped eleventh grade students and their instructors develop skills with both *HyperCard* and a special hypermedia program called ACCESS (discussed in the description of the research site). During the summer of 1992, I taught an introductory *HyperCard* course to a group of adult learners. In addition, I presently face the challenge of grading the work produced by students in a distance education course in hypermedia offered by the International Society for Technology in Education (ISTE). Each of these activities has contributed to my appreciation of the challenge and the potential offered by hypermedia systems.

Like many other people, I have found that students are interested in and excited by hypermedia environments. However, I have been disappointed by the research in this field. "Hypertext design is theory-rich and research-poor. . . . Its potential remains unverified. Little empirical research has examined the results of interacting with hypertext" (Jonassen, 1988, p. 14). "The hypothesis remains unproved that, with little guidance, people can construct really good trails, really good webs that help them and help other readers" (Van Dam, 1987, p. 20).

As I continued to seek an answer to my personal question of being able to share my intended concept via hypermedia, I began to consider the issue of hypermedia from the view of students involved in its use. Students at the high school level have already spent a number of years interacting with printed material. I wondered if their reaction to using a hypermedia system would be similar to my own experience. Generally, adults exhibit more difficulty in adjusting to technology than young people. Would young people immediately accept the environment created by hypermedia presentations as natural?

Education has been my chosen profession for many years. I have worked to increase my own repertoire of teaching skills and range of tools to use in the classroom. I have undertaken considerable reading discussing the potential of technology in the classroom. I have watched young people accept as natural the world of computers—a world that to me is endlessly complicated and fascinating. My interest in learning with technology combined with early reports on the advantages of non-linear presentations has guided me towards further investigation into the possibilities of learning via hypermedia.

Description of the Research Site

At a large urban high school, a small group of teachers are offering an innovative program of study to students called United States Culture (USC). The USC course of studies provides an interdisciplinary, technology enriched environment to study culture as a unified theme. This program provides one option for students to complete the United States history and literature courses required in their junior year of high school. This option differs somewhat from the traditional, discipline based approach to these subjects.

The program includes activities designed to help students gain a better understanding of their present culture by providing insight into how this culture evolved. Historical events and literary selections are investigated from multiple perspectives to provide this understanding. Historical events are placed into context by considering their effect on both individuals and society at the time of the event and connecting the results of decisions made at the time to present conditions. Literary selections are used to help provide an insight into a personalized perspective of both people and events. By understanding how these events helped to shape today's culture, students may become better equipped to be effective members of their own society.

Students selecting the USC option are required to enroll for three periods of class time—second, third, and fourth periods of the day. Credits for the course are recorded as 10

units of U. S. history, 10 units of language arts, 10 units of fine arts, and 5 units of humanities. This is five credits more than three periods would normally provide. This compensates students for the extra time required to attend evening events arranged to supplement daytime class activities. Most students selecting this program are planning to enroll in post secondary education and these extra credits are helpful to their application process.

Computer Component

The computer lab component of the USC course provides a variety of activities. Student goals for this part of the program include (a) gaining skills with a variety of Macintosh applications including word processing and *HyperCard*, (b) exploring the information in ACCESS/*HyperCard* stacks to research topics related to literature and history, (c) authoring in ACCESS to create stacks, (d) expanding knowledge of technology to include skills with a variety of peripheral equipment such as scanners, printers, laserdiscs, sound resources, and cameras, and (e) providing the opportunity to further encounter the interrelationships and interdependence between topics covered in the USC course of study.

The first task students face in the computer lab is to gain a variety of Macintosh computer skills. The students learn to deal with the computer interface, network requirements, and a selection of software/hardware. Since students are faced by a diverse assortment of assignments during their school year, the word processing lessons emphasize a comprehensive study of *Microsoft Word, Version 4.0*. Students are encouraged to use their computer skills for producing assignments for all classes. The equipment in the computer lab is made available to students outside of class time when they are free to work on tasks of their own choice.

American Culture in Context: Enrichment for Secondary Schools (ACCESS) is a project developed by the Cognitive Science and Linguistic department of Brown University in Providence, Rhode Island. ACCESS represents the basis for an ongoing research project that involves four school sites working in conjunction with a research team headed by Dr. Kathy

Spoehr, professor at Brown University. ACCESS provides a large collection of stacks created by teacher participants to support the topics in U. S. history from 1770 to the present.

The USC students have the opportunity to use the ACCESS stacks to supplement the material they encounter in class or can locate in their school library. The collection of stacks, presently over 20 megabytes in size, continues to increase when student stacks are added. The instructors select the stacks to be added by determining the extent the student created stack contributes to the information needed for the course. Class assignments are designed to take advantage of the ACCESS/*HyperCard* stacks and help students focus on the stack's content.

Description of the ACCESS Hypermedia Application

The ACCESS research tool developed at Brown University is based on the *HyperCard* program created by Bill Atkinson. The five objects that make up the *HyperCard* environment are stacks, cards, backgrounds, buttons, and fields. The HyperTalk programming language is used to control the interaction of the objects. ACCESS was developed to mediate between the students and *HyperCard*. This front-end or user interface is intended to eliminate some of the more difficult aspects of *HyperCard*, add some convenient tools suggested by the teachers involved in the development of the original materials, and provide the means of gathering the empirical data needed for the continuing research. However, ACCESS depends on *HyperCard* functions to create the hypermedia environment it provides.

Use of ACCESS is limited to the students involved in the research project from Brown University. To ensure this restriction is observed, ACCESS has a special entry process. Every student has a unique user name and everyone uses the word Sheldon as the password. Once the entry steps are completed, the user can move to the screen shown on the following page (see figure 1). From this screen, the user can move to whatever file they want to use.

This first card provides buttons (the stack icons in figure 1) that when activated move the user to the stack. This method of moving to a stack requires the user to be aware of which

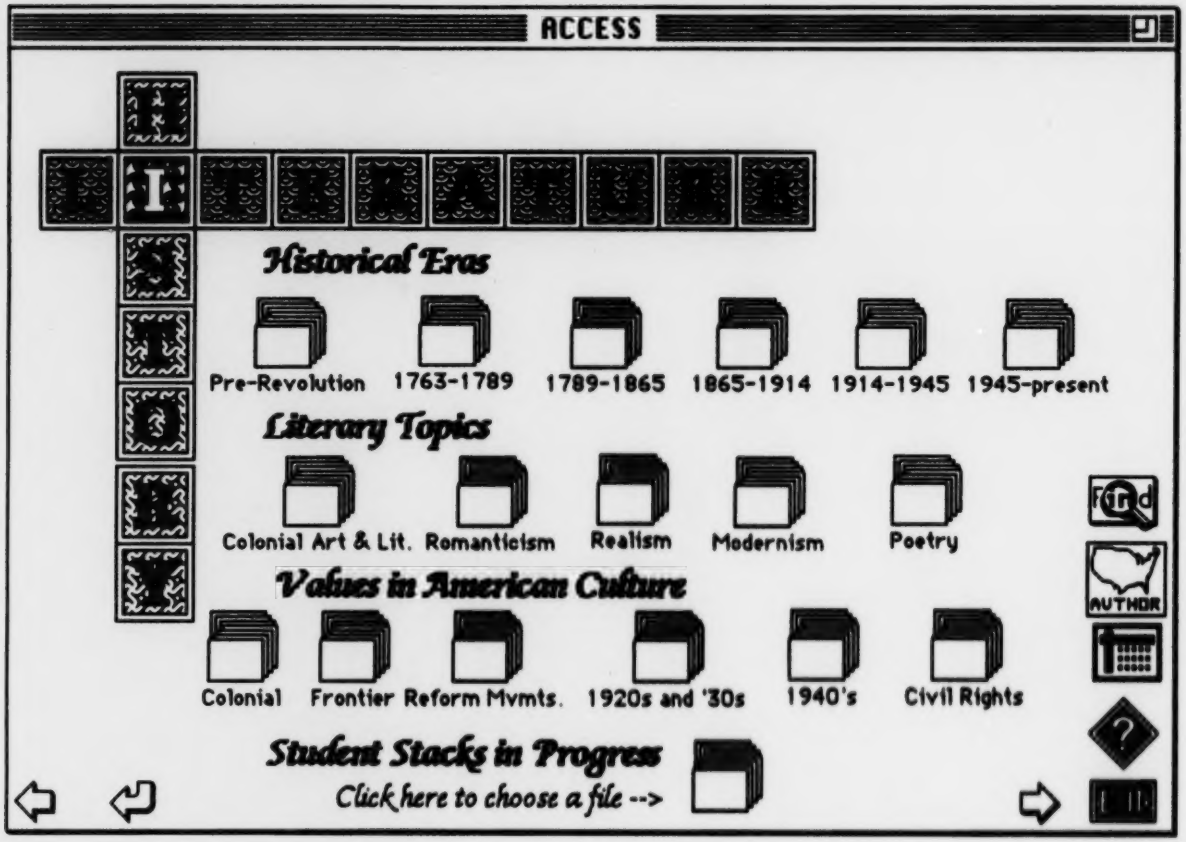


Figure 1: Opening card in ACCESS.

BEST COPY AVAILABLE

category the stack is in. The three categories include historical era, literary topics, and values in American culture. For example, the Gilded Age stack is found in the historical era of 1865-1914. By selecting the button for that era, the user arrives at a second card that lists the Gilded Age stack as one of three historical era choices. The left side of the card lists four stacks on literary topics.

Students do not need to use the buttons that are on the opening card. If a student has forgotten what era or category the stack is in, other options can be used. The Macintosh's ability to work from menu choices and keyboard shortcuts provides an alternative. A key-stroke combination produces a window that enables the user to switch drives to find the desired stack. From the opening card the user also has the option of activating the find feature, begin to author a new stack, consult the help card, or exit the program.

The ACCESS help card is available from every card in an ACCESS stack and is reached by using the question mark button shown in figure 1. The information on the help card provides the user with the instructions needed to understand the icons and buttons used in ACCESS. The help card is shown at actual size on the next page (see figure 2).

ACCESS Standardized Stack Appearance

ACCESS has been designed to create a consistent appearance among all stacks created with the program. Many of the button icons and placement of buttons are automatically determined by ACCESS. For example, the three arrow icons on the bottom of the cards shown in figure 1 and figure 2 are automatically placed and always produce the same action. Other buttons appear as a direct result of user choices. For example, any card created as a next in series will automatically have a button placed in the upper left corner. This button is shown in figure 2. Other buttons and icons must be placed by the user. For example, the light bulb icon is a standard signal to indicate more information has been placed in a field that appears only when the button is pushed.

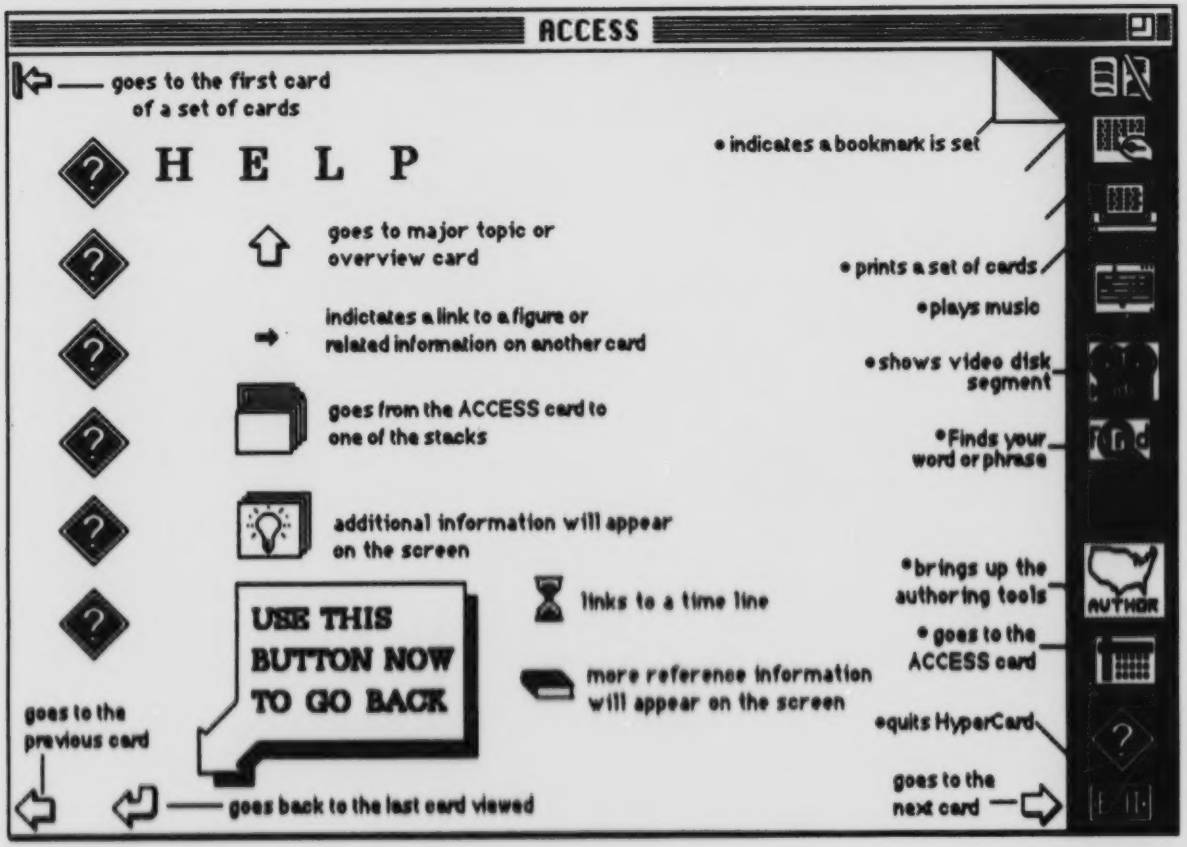

ACCESS
goes to the first card of a set of cards
H E L P
goes to major topic or overview card
indictates a link to a figure or related information on another card
goes from the ACCESS card to one of the stacks
additional information will appear on the screen
links to a time line
more reference information will appear on the screen
USE THIS BUTTON NOW TO GO BACK
goes to the previous card
goes back to the last card viewed
goes to the next card
• indicates a bookmark is set
• prints a set of cards
• plays music
• shows video disk segment
• Finds your word or phrase
• brings up the authoring tools
• goes to the ACCESS card
• quits HyperCard
AUTHOR

Figure 2: Help card in ACCESS.

BEST COPY AVAILABLE

The gray area on the right side of the card shown in figure 2 appears on all ACCESS cards except the introduction screen. The actual number of buttons that appear in this area varies according to the card's content. The conventions explained on the help card are used to establish a consistent environment. Once the conventions are learned, the user can cope with the navigational cues in any ACCESS stack.

Figures 1 and 2 show the actual card size available to users of ACCESS stacks. The amount of screen visible at any one time is restricted to this space. Although this card is the standard *HyperCard* size, the gray area on the right side of the card is reserved for standard buttons. This reduces the available space slightly from the standard *HyperCard* screen.

ACCESS Special Features

The use of ACCESS stacks as learning resources is aided by a number of features. To assist with browsing activities in the stacks provided, the find feature can be used to search for a specific item. Using this feature allows the student to obtain a list of all cards containing references to the key word used to initiate the search. The student is then able to move directly to any card on this list.

Another special feature of ACCESS is the bookmarking device that places a special mark on cards (shown on the upper right corner of card in figure 2) and adds the card name to a list. The button on the extreme upper right corner (see figure 2) provides a drop down menu displaying the list of marked cards. Students may return directly to any marked card on the list. The list of marked cards can be kept for another session.

ACCESS includes a note taking feature so the user can make notations and record points of interest during the browsing process. The note taking option does not offer all the convenient features of most word processors. It does provide a convenient and unlimited writing space. The notes window moves with the user from card to card and can be resized. The user can save the notes and print them from within any ACCESS stack.

ACCESS Authoring Features

ACCESS provides a special palette of tools to be used when creating a stack. The special authoring tools palette (see figure 3) has been designed to make the steps convenient and easy to complete and record data for the Brown University research project. The author button on the lower right of any card (see figure 2) will allow the user to open the special palette. To add an object to the stack, the user uses the appropriate button followed by the do button.

The author palette allows the student to create a number of objects. Reading the palette from left to right, top to bottom, the buttons allow the user to create a stack, create a card, add a field, open the *HyperCard* tools palette, place a button and popup field combination, place a topic button, add an arrow text link between cards or stacks, and lock the stack. All of these operations are done in the same way. The appropriate button is used followed by the do button. The operations can be reversed by selecting the appropriate button and then pressing the undo button.

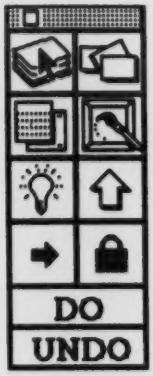


Figure 3: The authoring palette in ACCESS.

The graphic below shows the authoring tools palette provided in ACCESS being used to create a stack (see figure 4). The highlighting on the stack button indicates the user has used the button sequence stack and do to begin a new stack. The dialogue box on the right appears as the first step. After the stack is given a name, a new dialogue box appears. This asks the user to provide the name for the first card in their stack (see figure 5). The name placed into this dialogue entry will then appear in a field in the upper right corner of the card.

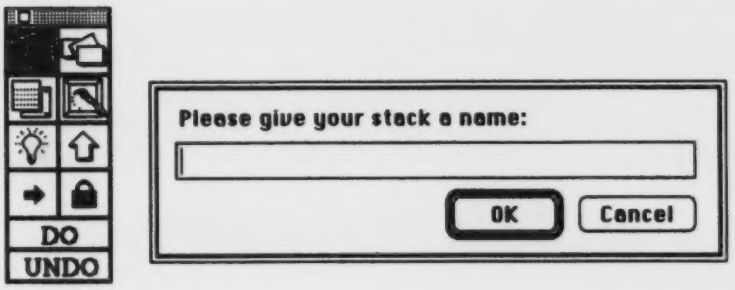


Figure 4: Creating an ACCESS stack.

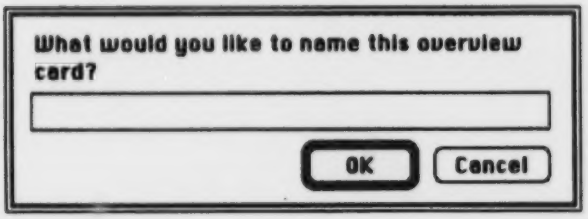


Figure 5: Naming the ACCESS card.

As the user creates new cards and buttons, dialogue boxes ask for names that will appear on the card. To assist in navigation an automatic count of cards is placed on cards that are created as a series—cards that complete a single chunk of information. The example below shows a portion of a card from the F. Scott Fitzgerald stack (see figure 6). The text on the

upper right shows the card title and the card count. Providing the numbering assists the user in making decisions about using the material. If the user is on card 5 of 19 and is not finding the information useful, they may decide to leave the strand. If the user was on card 5 of 8 they might continue to skim the strand because they are almost through the material. Knowing the extent of the strand and the current position in the strand, helps to guide the interaction and assists in navigating the stack.

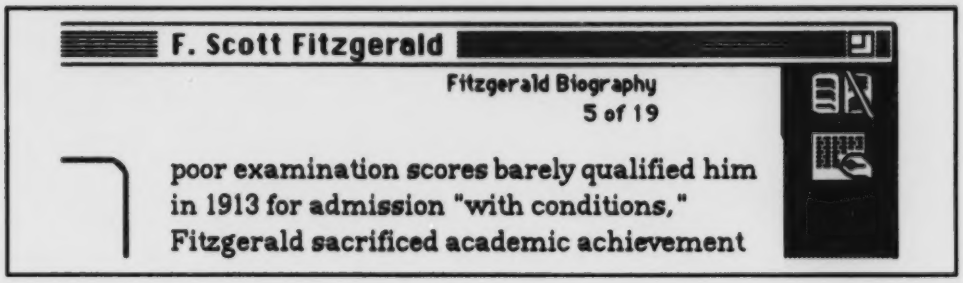

F. Scott Fitzgerald
Fitzgerald Biography
5 of 19
poor examination scores barely qualified him
in 1913 for admission "with conditions,"
Fitzgerald sacrificed academic achievement

Figure 6: The card title and count.

One of the special features provided by *HyperCard* to assist the communication process is the use of visual effects. A visual effect is used to draw attention to the change of screen content and to cue the user to the intent of the action. A stack which contains information on tropical plants and marine plants might use a strong visual effect to help the transition from one topic to another. The transition might be achieved by having the first card appear to divide in half and slowly have each half move outward. The new topic screen appears between the two pieces as they disappear. This visual effect is called a barn door open. To move from one card on marine plants to another card on marine plants does not warrant this strong visual display. To help convey unity in the strand of information the less attention a card change is given the better.

In ACCESS, the user does not have the power to select the visual effects. The application designers made the decisions and built automatic choices into the application itself.

For example, the topic button is placed on the first card in a strand of information. The topic button moves the user to a higher level of information. Usually this link connects the first in series card to an overview containing the strand choices. ACCESS uses the visual effect of iris close. This makes the card content appear to move toward the center of the card and disappear. At the moment when the card content seems to disappear, the overview card replaces the screen content. Since every topic button uses this same visual effect, the user learns to associate this visual cue with the action of moving upward in the information hierarchy.

ACCESS Collects Research Data

ACCESS has been designed to provide researchers with information about the manner in which students use hypermedia materials. ACCESS maintains a journal of the pathway taken by each user while inside the ACCESS program. The application records the names of buttons, cards, and stacks used and the time spent on each card. Once this feature has been activated, a new journal file is created each time the user gains entry to ACCESS. The lab instructor gathers the journal entries of each student from time to time and mails the material directly to Brown University. Part of a journal entry from October 14, 1992 (see figure 7).

In addition to gathering the information specific to the use of the hypermedia documents, the journal entries provide additional information. Each journal entry is given a heading that includes both the date and the time the entry is started. This information provides the researcher the ability to track the amount of time students spend interacting with the hypermedia tools outside of scheduled class time.

```
Journal for USC49 10/14/92 8:43:09 AM
A11,ACCESS,2,
accessHome,ACCESS,116,
Overview,Pioneer.USC49,14,
accessHome,ACCESS,8,
Overview,Pioneer.49,63,
Native Americans 1,Pioneer.49,0,
Overview,Pioneer.49,381,
Farming 2,Pioneer.49,1,
Native Americans 1,Pioneer.49,3,Topic
```

Figure 7: ACCESS journal entry.

Arguments For and Against Hypermedia

The decision of the teachers of the USC program to use hypermedia has initiated a great deal of discussion. The question of switching teaching methods from traditional textbook approaches to electronic formats provides an ongoing controversy. Indeed, "current empirical research has no clear evidence for whether hypertext is in fact superior to paper" (Nielsen, 1991, p. 12). People supporting the potential of hypermedia maintain that non-linear presentation is more natural to the learner. They believe this implies greater learning will take place.

The argument, however, is far from settled. Dillon (1991) suggests that the perceived distinction between print material and hypermedia presentations may be artificial. Making a distinction "assumes, for example, that paper text can only be read in one way and that readers will prefer to have texts restructured into linked nodes. There is little evidence to support either assumption" (p. 100).

Other writers express doubts about using hypermedia in education. They point to a lack of research on hypermedia's capability to increase learning or its cost effectiveness.

> In terms of educational use of these systems, it is unclear that any progress has been made. The effort in developing the technology has not been matched by a similar concern with the pedagogy. . . . At present it is an article of good faith that multimedia

> [hypermedia] is a good thing for education and training. There is no evidence that multimedia enhances learning, or makes it more cost effective. (Alty, 1991, p. 32)

Another perspective on the hypermedia debate concerns the distinction between classifying hypermedia presentations as informational or instructional. "*Information* has been described as a process, a flow of messages with many functions, only one of which is to instruct" (Grabowski, & Curtis, 1991, p. 3). The same writers go on to say "*instruction*. . . . may be defined as information 'which has been specifically selected, organized, and sequenced with the *deliberate intent*,' that the consumer of the information will remember, apply or act upon it now or in the future" (p. 3). The complexity of hypermedia makes this distinction difficult to define but the writers conclude "this diffusion in educational setting is evidence that an immediate need exists for researchers and designers to examine the learner's search processes and strategies as they use this tool [hypermedia] to determine what, if any, learning results" (p. 2).

The hypermedia environment observed during this research project is representative of the type of environment many schools could easily provide. For most part, the tools are available within *HyperCard*. Additional facilities include scanners, CD-ROMs, videodiscs, digital cameras, and sound resources. Although ACCESS includes a number of additional convenient features, schools could learn to create these features themselves. The question is one of determining if the steps required to provide this approach to learning justifies the time and effort it would take.

Content of the USC program

The content of the first semester of the USC course begins with events in 1877 and continues through approximately 1929. The presentation of material is organized chronologically by historical measures and is divided into three separate time periods. These time periods are the basis of units that provide a convenient means of obtaining formal

assessment for reporting purposes. Unit one is titled "The industrial revolution creates the modern age 1877-1915." Unit two is called "Dawn of a new century 1877-1920." The third unit is "The 1920's: Age of transition and anxiety 1919-1929." Each unit includes a wide range of topics from within the historical classification and the literature choices are used to support the historical presentation.

Unit One

The first unit, "The industrial revolution creates the modern age," includes a number of historical events. The topics include (a) farmers settle the great plain, (b) invading the Indians' homeland, (c) US government Indian policies, (d) exploring the cowboy image—the western myth, (e) expansion of industry and the changing nature of the American workplace, (f) transportation and communication, (g) urbanization and city life, (h) business becomes more complex—the growth of corporations and large trusts, (i) political machines acquire more power, (j) the beginnings of the labor movement, and (k) patterns of immigration and increasing demands for restriction of immigration. These historical events are presented using the standard textbook The Americans, films such as Lonely are the Brave and End of the Trail, and teacher prepared handouts.

To increase the students' appreciation of how these historical events are representative of 'real people in real life', the literature is selected to provide further insight into the topics of study. The works chosen may be by writers of the particular period or be works considered as excellent descriptions of the people of the time. For this unit, the literature studies include My Antonia, selections from Daughters of Copperwoman, The Way, and Washo Watched. With each item, students are encouraged to make connections between the material in the literary work, the content of the history lessons, and their personal life.

To supplement the traditional material being used, the program includes a number of ACCESS/*HyperCard* stacks produced by teachers specifically for course use or by students

that have previously taken the course. For this first unit, the students are given an opportunity to interact with four stacks. Two stacks, KayFrontier and Frontier Values, were developed by teacher participants in the research project and present additional information on the frontier period. Perspectives of Past and Present: Native American Issues and Christopher Columbus are stacks created by two Sheldon students in last year's USC class as their final assignments.

Unit Two

The second unit of study in the USC course is "Dawn of a new century covering the period from 1877-1920." The specific topics include (a) demands for reform grow, (b) the beginnings of the Populist movement, (c) the struggle for women's suffrage, (d) improvements in education, (e) sources of information multiply, (f) leisure time increases for most Americans, (g) expansionist sentiment and the war with Spain (1898), (h) the United States becomes a world power, (i) the progressive movement and Teddy Roosevelt, (j) the outbreak of WW I and America's attempt to remain neutral—America's role in the final victory, (k) President Wilson and the Versailles Peace Treaty, (l) the African-American experience in American Black folklore, (m) black artists in America, and (n) the Harlem renaissance. A wide variety of resources are used and students are given considerable experience with numerous art works by black artists.

The literature component includes a number of supporting selections to the topics encountered in the history setting. Students use The Hairy Ape to do an in-class dramatic reading. Other selections include The Awakening, All quiet on the Western Front, Their Eyes are Watching God, some poetry, and a variety of short stories. The discussions and assignments attempt to make the material relevant by providing insight into the way in which historical events affected individuals. Effort is made to help students find ways to connect the ideas with their own life experiences.

For this unit, four stacks are selected for use by the students to supplement the other material. The stacks are Gilded Age, 1900-1914, WW I, and Harlem Renaissance. All of these stacks have been produced by the teachers involved in the ACCESS research project.

Unit Three

The final unit of the semester includes "The 1920's: Age of transition and anxiety, 1919-1929." The topic headings included are (a) a troubled postwar world, (b) manner and morals change, (c) heroes and issues of the 1920's, (d) political conservatism: Harding, Coolidge, and Hoover, (e) the second industrial revolution, (f) modernism and American art, and (g) Lindbergh's flight and the emergence of the modern hero. The material is supported from the textbook The Americans, films, and other material.

The literature for the unit includes The Great Gatsby and a varied selection of poetry by writers such as Robert Frost, E. E. Cummings, and T. S. Eliot. The intent of the selected works is to provide further insight into the events that are studied as historical by giving a different perspective to the action and atmosphere of the time.

There are four stacks to be included as supplementary material during this unit. The teacher produced stacks are F. Scott Fitzgerald, Roaring 20s, 20s and 30s, and Reform Movements. A great deal of the information provided in these stacks is not available to students through the local school library. The hypermedia resources are valued both because they provide a unique experience for students and because they help to enrich the available information base.

USC Curriculum

The curriculum of the USC course of studies is very similar to the content of traditional classes in this school district. The subject matter that is studied is based on similar resources

and covers the same time period and events. However, in the USC setting the manner of presentation and the emphasis has been altered. Each historical event is viewed from multiple perspectives, with attempts to provide students with an understanding of the motives and reasons behind each event. The themes presented in the literature selections are supported by the relevant historical events, giving the information a personal view not traditionally presented. Integration of concepts provides students with the opportunity to view events from many perspectives and build a greater understanding of their own nationality.

The USC instructors work towards a set of goals for this special program. These goals may differ from what traditional classes strive to include. Many skills students are expected to gain are undoubtedly common to both situations. Examples would include skills such as improving writing skills, synthesizing knowledge, and understanding major historical events. In addition to the technology goals, this special program promotes increased ability for verbal expression, increased awareness and understanding of cultural differences amongst specific groups within the United States, and increased understanding of the process of learning. Rather than pursuing a comparison of traditional history and literature classes versus the USC course of studies, this study focuses on the issue of learning via hypermedia.

USC Organization

The USC program is organized to include a wide variety of experiences for students. Students spend some classes as one group of 55 taught by all instructors. For other classes the students may be divided into two groups where one group is using the computer lab and the remaining students are working with the literature/history teachers. When seminar sessions are planned, the groups are made even smaller and the history and literature teachers each work with a small group while the computer instructor helps others in the lab. Some classes involve many small groups working independently to prepare material for sharing with the rest of the class.

The expectations for students in the USC course of study are based on the belief that every student is present to learn and is willing to help others achieve that goal. The atmosphere emphasizes respect for others regardless of their expressed opinions or views and a willingness to be open to new ideas and values. During the semester, students produce many individual products such as essays, outlines, graphics, and ACCESS stacks. The traditional activities provide the major portion of the course requirements with the hypermedia activities serving to supplement these activities. The variety of assignments provide the opportunity for individual efforts to be recognized and evaluated.

Many assignments are group products providing students the experience of cooperative learning. Each student gains understanding from listening to interpretations of the material by other students and sharing their own thought on the topic. Students learn that group success depends on individual efforts being combined to achieve results. These group activities provide students an opportunity to learn to work efficiently within varied group structures. For group projects, evaluation is done on the project with each student receiving the score awarded to the project.

Research Questions

The USC program of study with its use of *HyperCard* and the ACCESS hypermedia learning environment is a rich research setting. This dissertation will address the following research questions.

1. What are the students' perceptions of their learning within the hypermedia environment provided by using ACCESS/*HyperCard* in the United States Culture program?
   - What are some of the more difficult aspects of hypermedia as perceived by students?
   - What are some of the factors that students perceive as an advantage if the information is given in hypermedia format instead of print information?
   - What methods do students perceive as effective in determining that they have completed the task of learning the material in a hypermedia format?

- What do students perceive as advantages to producing their own work as an ACCESS/*HyperCard* stack rather than as a traditional print product?
- What do students perceive as needed personal skills and technical equipment to function productively and efficiently in the hypermedia environment?

2. What do students perceive the hypermedia environment provides in terms of helping them recognize the relationships and associations inherent in the material presented?

The researcher hopes that by finding answers to the research questions, direction can be provided for those designing hypermedia products. In addition, guidelines for teachers wishing to incorporate hypermedia into their classrooms can be developed. If student reaction is overwhelmingly negative, perhaps a great deal of time, effort, and money is being invested in the wrong place. If student reaction is overwhelmingly positive, perhaps even more time, effort, and money should be invested. There are many features of hypermedia that appear to potentially provide some of the motivation, excitement, and interest exhibited by students when they are enjoying their learning experience. The medium is still evolving. It is hoped that the pending research will assist the process.

CHAPTER II

LITERATURE REVIEW

Introduction

This chapter summarizes and analyzes information available from a wide range of sources. The literature review investigates a number of major areas. It looks briefly at terminology of the field and provides information on some of the features of a hypermedia system. The problem of cognitive overhead is presented. A discussion of communication processes in paper and electronic forms provides background information on the technical differences in hypermedia communication and traditional print. The guidelines emerging for communicating with sounds and images are discussed. Examples of four different hypermedia systems are presented. There is a discussion on the process of learning and, in particular, learning from hypermedia based presentations. This includes topics such as collaboration, ill-structured domains, and *HyperCard*. Lastly, this chapter makes an effort to answer the research questions based on the information included in the literature review.

Terminology

The expressions *hypertext*, *hypermedia* and *multimedia* are confusing and precise definitions tend to be evasive. Franklin comments, "defining hypertext is much like describing beauty: part of it is in the eye of the beholder" (1989, p. 37). These three terms convey complex ideas and not every instance where they are applied exhibit exactly the same features.

Jacob Nielsen (1990) discusses his definition of the term hypertext. Hypertext is "*nonsequentia*] . . . several different options are presented to the reader and the individual reader determines which of them to follow *at the time* of reading the text" (p. 1). Nielsen goes on to explain his belief that restricting hypertext to text characters only is unrealistic in a computer environment. Since computer technology is capable of dealing with sound and images in much the same manner as handling text characters, restricting the term seems unnecessary.

Bourne (1990) follows this same convention stating "hypertext allows the user-programmer to put together interactive information . . . to take text, graphics, sounds, video and animation, and combine them into one program" (p 166). Layman and Hall (1991) provide the information that:

> A hypertext system is one which allows authors or groups of authors to link information together, create paths through related material, annotate existing texts and create notes that point readers to the same or other units of information, thus creating a database of nodes and links that can guide the reader down a particular path or let them freely range through the information. (p. 114)

All definitions include the requirement of freely moving through the information but the confusion of what constitutes text is evident.

To ensure the flexibility implied in these definitions, Slatin provides a further definition. "*A hypertext (or hyperdocument) is an assemblage of texts, images, and sounds—nodes—connected by electronic links so as to form a system whose existence is contingent upon the computer* [italics in original]" (1991, p. 56). Slatin eliminates any non-electronic presentations from being classified as hyperdocuments with his demand for an electronic link.

If the preceding definition of hypertext is accepted, there is no additional concept to use to distinguish a meaning for hypermedia. Azarmsa (1991) states "hypermedia is a term used to describe linked-information presentations that could contain several types of media, such as text, graphics, audio, and video. Hypermedia may contain several layers of information, with each layer related to many others" (p. 165). The associations existing in the information base are made visible as electronic links. Picher et al. (1991) emphasize that

"hypermedia is any application that allows users to forge their own nonlinear paths through images, sounds and text" (p. 23). Hypermedia and hypertext are most frequently used interchangeably with personal preference dictating actual choice.

Multimedia refers to presentations using a wide range of technology. Some of the common mediums employed are videodiscs, CD-ROMs, and movies. As Franklin and Kinnell (1990) suggest "the difference between hypermedia and multimedia lies in the level of interactivity possible" (p. 6). The key characteristic of multimedia is the relatively inflexible interface provided (Franklin & Kinnell, 1990, Landow & Delaney, 1990). Movement is primarily forward or backward. The locus of control is retained by the application itself and the opportunity for user decisions is limited. This restriction of user control is the one quality that presently identifies multimedia presentations from those classified as hypermedia or hypertext.

As the power of available technology increases, this restrictive approach to multimedia's definition becomes increasingly artificial. Azarmsa defines "multimedia as the integration of text, audio, graphics, still images and motion pictures into a computer-controlled product" (p. 157). He makes no mention of restricting movement to backward or forward. Ambron and Hooper (1990) now use the term *interactive multimedia* to reflect the increased flexibility of multimedia's environment. Interactive multimedia is:

> A collection of computer-centered technologies that give a user the capability to access and manipulate text, sounds, and images. . . . Multimedia programs . . . will enable users to access not only libraries of text documents but also storehouses of music, sound effects, speech, still images, animations, and movies. In addition, multimedia users will be able to manipulate this lexicon of material and add their own material. (p. 11)

Hardware is evolving into an integrated environment where the various media can be used and controlled from a single unit. "Hypermedia is multimedia. However, whilst multimedia combine different sorts of audio-visual information, hypermedia integrate these within one computer based system" (Vanio-Larsson, 1991, p. 235). As this integration increases in

availability and power, the distinction between hypermedia and multimedia will increasingly disappear.

A number of other terms need to be considered prior to further reading. A hypermedia *reader* is "a collaborator, constructing and reconstructing the text, choosing his own path through it" (Joyce, 1988, p. 13). Joyce describes a hypermedia *author* as the first writer or the person to construct the hypermedia presentation. The author provides implicit directions for an optimal movement through the information with choices that allow the reader to create an alternative presentation, equally valid to the author's perception. This means "hypertext documents are created in part by the author (who creates and places the links) and, in part, by the reader (who decides which threads to follow)" (Berk & Devlin, 1991, p. 5).

In a hypermedia environment, one might use the term *text processing*. This simply expands on the notion of word processing by "making text transparent, inviting readers to consider parallels, explore multiple alternate possibilities, and participate in the uncertain process of discovery and creation" (Joyce, 1988, p. 3). The user of the hyperdocument creates a unique text by their choices. Depending on the particular goal in mind at the time of interaction, the user will process a different text for each particular purpose. Different users will develop individual versions even when guided by the same goal.

Where information can be readily layered and connected, the term intertextuality can be applied. This term reflects "the text in question in reality is based on texts that preceded it" (Havholm & Stewart, 1990, p. 8). Intertextuality can be made explicit in hypermedia where the electronic linking ability can be used to demonstrate the dependence and associations between documents. *Grouptext* is "text that people create or access collaboratively" (Rada, 1991, p. 667). With the collaborative nature of hypermedia, the role of author and reader overlap, and any document may reflect the influence of a number of users' input.

Features Appropriate for Hypermedia Systems

There has been considerable discussion about the design and presentation of information in a hypermedia environment. Hypermedia allows "creative authors to present material in an entirely novel way, exploiting the new medium rather than using techniques taken from paper documents" (Brown, 1991, p. 46). Presentation via hypermedia provides exciting possibilities. "The potential benefits of hypertext are the information will be better—the readers will more frequently reach the information they need—and will be obtained more quickly" (p. 51).

Authoring guidelines are being developed and the following features are identified (Hartman & Schell, 1991, Brown, 1991, Jonassen, 1988, McKnight, Dillon & Richardson, 1989, Osborn, 1990, Bielawski & Lewand, 1991) as being necessary for effective communication in a hypermedia product. These investigators agree that systems should make use of a meaningful metaphor and provide assistance for easy navigation. Tools should be available that support browsing in the system, taking notes during interaction with the material, and searching the text for specific items. Finally, the system should include links placed by the author of the document and allow the reader to add new links. These features will be briefly discussed.

Use of a Metaphor

In the world of traditional print, writers often make use of the concept of a metaphor. In a hypermedia medium, the metaphor provides a way to convey to the user the manner in which they might interact with the system. "We must rely on metaphors such as 'navigation' to describe the active processes one must engage in . . . and highlight the active, strategic role taken on by the reader" (Gay & Mazur, 1991, p. 271). "Hypertext authors use metaphors in order to establish conventions readers can follow so they can ignore the interface they need to

use to find information and just find the information" (Shneiderman, Kreitzberg, & Berk, 1991, p. 156). The metaphor functions as an implicit set of directions on how to work within the hypermedia product.

Selecting a metaphor is critical to the overall success of the hyperdocument. "Effective metaphors are created by linking the known with the unknown" (Shirk, 1991. p. 198). Since the author must decide on the known McKnight, Dillon, and Richardson (1989) suggest "providing a metaphor and hope . . . the user can employ it. . . . The most commonly provided metaphor is that of 'travel'" (p. 175). Since travel has many well known and common elements, the user can call on previous experience to help him in the present situation. "Metaphor familiarity facilitates learning and reduces anxiety. . . . An inappropriate metaphor might make it harder for the user to acquired the necessary concepts" (Shneiderman et al., p. 156).

Closely related to the travel metaphor is the concept of the hyperdocument as a *landscape*. Florin describes the *"HyperCard* environments as *information landscapes* which can be thought of as virtual towns or intellectual amusement parks" (1990, p. 29). From either perspective "you can either merely walk along pathways and look at roadside attractions, or you can choose from many different options" (p. 29). This familiar construct helps the user to relate to the electronic presentation and provides subtle suggestions for making choices during its use.

A common convention in hypermedia is to use the book metaphor to help the user bring their skills with print material into the electronic setting. "Some strongly advocate adopting and sticking to a single metaphor (e.g., all hypertext should look like a book). Others believe each interface should be custom written for the application and that readers be given multiple interfaces from which to choose" (Berk & Devlin, 1991, p. 14). The book concept does provide assistance but "book metaphors may mislead readers into believing they can easily grasp the size or organization of the hyperdocument" (Shneiderman et al., 1991, p. 156).

In this case, the choice of metaphor may bring too much information from past experience into the electronic setting.

Gay and Mazur (1991) have done extensive research with an electronic product called *The Bughouse* . In this particular product, the metaphor in use is the "Victorian farmhouse—general themes are organized by rooms—objects in the rooms connect to detail nodes" (p. 276). Some "students reported that although they had difficulty navigating in a local sense, they were able to remain oriented in the hyperdocument because of the use of a house as the overall visual organizer" (p. 272). Gay and Mazur add that:

> During iterative testing of *The Bughouse*, 45% of participants reported they had problems with spatial orientation. They stated they were lost or turned around in the defined, or metaphorical, space of the program. . . . Although they realized that certain specific information could be found only outside the house, they were unable to locate the door which would allow them to exit the dwelling—they knew where they wanted to go, but they could not figure out how to get there. (p. 273)

This metaphor provided great assistance on a global level, but left the users with some navigation problems at the node level.

Browsing Tools

Books provide users with a number of features designed to encourage the reader to skim the material and gain information about the structure and the content of the material. Browsing tools in books include the table of contents, index, introductions, and summaries. Hypermedia designers often provide the user with a browsing tool to allow a similar orientation process to occur in the hyperdocument space. "Viewers should be able to skim or browse a hypermedia document as they would a document on paper and they should have the means to predict where in the hypermedia particular information is stored" (Picher et al., 1991, p. 47). A number of options have been developed to meet this need.

A browsing tool can provide assistance to exploration in hypermedia. "These tools help orient users by showing them the overall structure of the system and, sometimes, their current

place within it" (Bielawski & Lewand, 1991, p. 48). In this way "browsing involves both looking through the structure of a system and browsing through the hypermedia information itself" (p. 49). One type of browsing tool "shows the structure of the database as a tree diagram" (Feller, 1992, p. 6). The browsing tool might provide "a presentation of a 'pre-planned' tour" (Oren, 1990, p. 133). In this type of tour "the designer may relinquish the control to the system" (Hammond, 1991, p. 116) and to ensure the users meets all the information the author feels is critical to orientation.

Many hypermedia systems make use of a browsing aid called a graphic browser which serves to show structure and present location.

> The graphic browser lets you see the . . . structure, its nodes, and their interconnecting links. Most of it is dedicated to a local view of the network: a zoomed-in view of the current area of interest, with nodes and links in full detail. . . . A portion of the browser contains a global overview: a zoomed-out view of the entire network without node labels, link-type icons, and secondary link. (Begeman & Conklin, 1988, p. 256)

Begeman and Conklin caution that this approach does require considerable display space and in large systems can become as much of a problem as the system itself. Others comment "visualization approaches depict regular hierarchies well, but are much less effective at revealing regular structures in more complex hypertext webs" (Garzotto, Paolini, Schwabe, & Bernstein, 1991, p. 186). The larger and more complex the system, the more difficult to provide the visual information without confusing the user.

Navigation Aids and Difficulties

From the earliest writing in the field of hypermedia, the topic of navigation has created a great deal of interest and concern. "Readers form a mental representation of a paper document's structure in terms of spatial location and overall organization . . . derived from years of exposure to the information type . . . or a quick scan of the material" (Dillon, 1991, p. 95). Users cannot quickly scan all the material in a hypermedia system nor do they have years of experience to guide them. "Making the structure of the hyperbase explicit is one powerful

aid to navigation" (Picher et al., p. 39). Navigation in an information base where only a small portion is visible at any time takes the combined efforts of the author and readers.

> Navigation concerns the user of the system on two separate levels, global and local.
>
> Readers must be able to navigate both globally and locally through the hypertext structure. The global context stresses the big picture and helps the navigator to comprehend the organization of the program's extensive content. The local context of navigation, on the other hand, defines the specific tools which generally appear as on-screen icons and which enable the reader to make the leap to nodes directly connected to the current one. . . . Use of visual organizers along with overview maps and diagrams facilitate navigation in the global context. (Gay & Mazur, 1991, p. 272)

As suggested in the following section on visual communication, the local navigation depends on consistent use of icons and other card elements. "Use of article titles as navigational landmarks can reduce the disorientation readers of a hypertext inevitably feel" (Shneiderman et al., 1991, p. 152). It is suggested by Gay and Mazur that "the reader navigating a hyperdocument should always have the option to return to a home base and anchor...or to quit the program entirely" (p. 276). As Bernstein (1991) points out, by avoiding the violation of the expectations your system has established and providing a few safety net factors, the consequence of disorientation decreases rapidly.

The problem of getting lost in a hyperdocument results frequently in spite of the best intentions of the designer. "One reason people do get lost in 'hyperspace' is . . . they have lost their chain of thought or position in the document" (Beck & Devlin, 1991, p. 5). Nielsen (1991) points out that "a short response time so the text is on the screen as soon as the user asks for it" (p. 4) helps to prevent this lapse. Keeping the users attention focused on a continual presentation helps them maintain their concentration. However, as Nielsen points out, often the author cannot control for this factor since speed of presentation is frequently a result of the equipment being used for the interaction.

Hypermedia systems capitalize on the ease with which multiple forms of communication can be used. "Conventions for navigating video, pictures, and sound are necessarily more complex than navigating text alone" (Picher et al., 1991, p. 39). The design of the nodes is critical. Shneiderman et al. suggest "our research has shown that it is best to

keep articles short. We suggest that each node be a few screens long, and probably no longer than one hundred lines" (1991, p. 147). In her report on an extensive hypermedia system that avoided the usual navigation problems, Brown (1991) comments "the biggest reason why navigation problems have been kept in check was good authorship" (p. 49). Good navigation requires careful planning.

There is a second perspective from which to view the question of navigation. Bernstein (1991), for one, feels that a slight feeling of disorientation can increase the effectiveness of the presentation. "Disorientation is not inherently wrong; indeed a degree of disorientation, deliberately introduced and thoughtfully controlled and guided, can be a powerful tool for writers" (p. 293). He is adamant that using this technique can increase the dramatic intensity of a presentation and encourage adventurous exploration of the system. Bernstein does caution the designer to not overuse this particular writing device.

Placing and Designing the Links

Hypermedia's primary characteristic is the ability to present multiple pathways for the user to follow rather than the linear, sequential format of printed text. Garzotto, Paolini, Schwabe, and Bernstein's work (1991) "uses links selectively to convey part of a thought and to show how that thought fits into the structure of an argument" (p. 179). Assuming association of ideas is critical to the argument "the sophisticated, nonlinear structure of discourse is most effectively expressed by sophisticated, nonlinearly structured connections" (p. 184). An electronic link serves to make explicit to the user an association considered important to the presentation.

Links are very easy to put into place but the reasons for placement are difficult to isolate. ACCESS provides an automatic annotation field for explaining the reason for placing the link and describing the destination of the link. These annotation fields were frequently left blank by students working in the USC course despite specific instructions to include the

information (Smith, 1992). The links were well placed and effective in the communication process. The associations in the students' minds while easily shown by the links were extremely difficult to clearly express in sentence format. Frustration in using the annotation fields correctly was expressed by both students and instructors.

The very nature of hypermedia—being nonlinear in presentation—creates some difficult choices for authors. "The author cannot assume the reader has read nodes the author thinks should logically precede the current nodes. . . . The local context . . . must be explicitly communicated by author to reader through its structure and, in particular, with properly deployed links" (Berk & Devlin, 1991, p. 6). "The challenge becomes not that of creating a singular, linear line of logical thought, but of anticipating the various paths that potential users might want to pursue" (Shirk, 1991, p. 195). In addition to providing the choices, there is "a need to communicate possible choices as well as a sense of the consequences of these choices" (Shirk, p. 198).

The richness of a hyperdocument is heavily dependent on the decisions connected to links. Hyperdocuments should show the "interrelationships: each document should contain links to other documents. The more links contained in the documents, the richer the connectivity of the hypertext database. But each link should serve a clear purpose" (Feller, 1992, p. 7). "Wherever there is a need for elaboration, a link should be available so that readers can obtain the details at the point where they are mentioned. . . . Our style is to limit the number of links per screen to between 6 and 8" (Shneiderman et al., 1991, p. 150). To increase the connectivity possible in this format "instead of discussing a subsidiary topic which is not the main subject . . . allude to it and designate a phrase that refers to it as a link" (p. 147). The layering of the information is a major strength of the medium.

The author controls the options provided to the user. When organizing the database "the logical structure of hypertext is imposed by the author. This includes the relationship between links in the database, the relationship of links to nodes and the content and design of individual nodes and networks of nodes" (Shneiderman et al., 1991, p. 145). Authors must

decide on how flexible the presentation is to be. "The optimal level of control depends on the nature of the learners, on their familiarity with the materials, on their learning goals, and not least on the nature of the knowledge domain" (Hammond, 1991, p. 117). Once the system is in use, "learners may need to inform their choices with signposts and access mechanisms to help them through the materials or with instructional strategies to optimize the route taken" (p. 114). Shirk (1991) suggests routes are optimal depending on purpose, previous level of knowledge, and desired outcome from the interaction.

Filters, Indexes, Bookmarks and Note Takers

Many hypermedia systems include one or several of filters (find feature), indices, bookmarking abilities, or note takers. Each feature has a specific purpose. Some provide assistance in navigating and learning the content of the system. Note taking provides a convenience in gathering material to be reproduced apart from the system. Again, the designer of the system must decide the final form, if any, of each of these features.

The filter provides the means to move the user from mere exploration of the system to locating specific information.

> Filters . . . help to locate pertinent information by limiting the amount of retrieval information or narrowing the context for the search. . . . A hypermedia system may be filtered according to time . . . work from a list of key words or card-attributes . . . or those that search only summary information. . . . The filter restricts the search pattern according to the user's needs. (Bielawski & Lewand, 1991, p. 51)

Mukherjee & Phelps (1992) further explain the way in which a filter can be set up to optimize the search for a particular concept.

> The most general approach is to construct a list of words in the document, truncate these words to their stems, filter out non-meaningful words, and then to cross link all occurrences of those remaining, with the constraint of only one instance of a given target item linked in any one section of text. (p. 22)

The major drawback they identify with this approach is that the system creates a number of unnecessary links. They offer a more restrictive approach to remove some of the extraneous links and create more efficient hyperdocuments.

> Another approach is to work from a glossary of important technical terms. . . . Only items in the glossary were located in the text and cross-linked, again with restrictions on the number of instances of a target linked within the same section of the text. (p. 22)

In the large systems being designed by Mukherjee and Phelps, these devices establish the links to be followed upon request by the user.

The ability to search for a particular piece of information is assisted in print material by the structure of the book. As Campbell and Hanlon (1990) point out, using the find feature with keywords is very much like using the index and table of contents in a book. However, depending on the system, the electronic search is faster and more complete. Indeed, "one should be able to search for and locate specified terms or phrases within the text in nodes" (Perez, 1991, p. 215) in a way that promotes understanding of connections in the material. Campbell and Hanlon observe that after their students became familiar with the find feature in *HyperCard*, their skills as researchers in the library increased. They use the example of noting student recognition that searching for *Woody Guthrie* could also include a search for *music* and *folk songs*. "Previously students didn't know what they wanted to look up in the card catalog. Now they know exactly what they are looking for" (Campbell & Hanlon, p. 281).

An index is less often used in hypermedia. However, to help provide the user with an insight into the structure of the system, an index often serves as an introduction or overview. Shneiderman et al. (1991) suggest that an introductory article with references, index, and a summary would be useful in guiding the user's exploration. The introduction might include only high level index entries or only key references. When the index is alphabetized, the user gains a feel of the range and quantity of information in much the same way they would in printed information. They suggest a visual equivalent of the index could be a map illustrating the contents of the system. Again, the larger the system, the more difficult becomes the author's task of deciding what elements appear in the index or map.

Bookmarks often work in conjunction with the filter feature. "The bookmark is a placeholder within the hypermedia system for one or more nodes that have already been accessed or called. . . . Upon subsequent use of the system the bookmarks will serve as return reference points" (Bielawski & Lewand, 1991, p. 51). "When one places a 'bookmark' they are saving parts of mental states for later reference" (Oren, 1990, p. 128). Oren remarks that upon returning to the system after a length of time, the bookmark may no longer seem relevant. Also, "too many bookmarks will result in a situation akin to highlighting too much material in a printed text, reducing the overall importance of the marked information" (Bielawski & Lewand, 1991, p. 51). The author of the system makes the decision to include the feature or not. Each user decides on the value and application of the feature for themselves.

The built in notetaker has two separate philosophies for intent and use. Perez (1991) feels that a notetaker is "helpful for hypertext authoring systems to allow authors to attach descriptive notes to nodes" (p. 214). In this sense, the notetaker acts as an annotation device allowing every user to contribute something to the system. Since every user is given the opportunity to incorporate their own comments into the product, Perez uses the term author to include anyone creating or using the system.

A more frequent approach provides the notetaker as a notepad for recording thoughts, concepts, and items of interest to the reader. Oren (1990) suggests this approach. He sees the notetaker providing a way for the user to isolate pertinent information and extract the notations from the system. Since the notetaker seldom offers the convenience of a word processor, the user frequently requires further help to create a useful document from the notes. Oren suggests the convenience of the on-line feature may increase the user's focus while using the system.

Problem of Cognitive Overhead

Conklin (1987) points out that one difficulty in using hypermedia systems is the demands placed on the learner. He uses the term cognitive overhead. By this he means "the

additional effort and concentration necessary to maintain several tasks or trails at one time" (p. 40). The presentation of chunks of material is part of the mental challenge. "If the underlying information is naturally divided up into separate card-sized units, then the card-based approach is best. If not, dividing the material into cards adds an extra and unnecessary level of complexity" (Brown, 1991, p. 48). In addition to encouraging the author to write in small chunks, Oren (1990) suggests:

> *HyperCard* has several limits that can act to further *increase* cognitive load. *HyperCard* presents only one screen image at a time. This makes it more difficult to relate pieces of information in the system, because only one external representation can be viewed: All other relevant information must be kept in the students' memory. This is often noted as a problem in using *HyperCard*'s own Help stacks, where the exact nature of a problem might be forgotten before getting to the appropriate documentation, or where the way to fix it might be lost before returning to the point of difficulty (p. 128).

Not all hypermedia systems are as limited in node size as *HyperCard*, but the problem of cognitive overload is universal.

The amount of information that can be easily included in a hypermedia system is daunting.

> Information overload occurs when a reader receives too much data to process meaningfully. . . . Information overload is really a problem of understanding. When meaningfulness is lost, information becomes noise and people filter it out. When information is meaningful, readers accept it and organize it for later use. (Shneiderman et al., 1991, p. 147)

Dealing with information is to some extent a process of placing the current information into context with what is already known.

> Provide *just enough* information initially to ensure comprehension. When information is meaningful there is a natural cognitive process which occurs. It is as if the new information fits existing templates. . . . When these templates do not exist, or are not activated, the cognitive organizing mechanism does not function properly and overload results. (Shneiderman et al., 1991, p. 150)

Placing the information into appropriate nodes is difficult. Trying to balance the presentation to meet all the guidelines requires considerable effort. "Present *just enough* information at each stage. . . . Presentation should be complete, but not elaborated . . . with no conceptual

gaps . . . nor should there be details which clutter" (Shneiderman et al., 1991, p. 150). Judging what is just enough is a constant question to the author.

Hypermedia provides some unique advantages over traditional print information and includes some unique problems not met in conventional communication. The concept of working with numerous communication media in the same document while exercising the ability to create a personal pathway through the material is still a new idea to many. Bevilacqua (1989) makes an excellent summary observation in stating "perhaps as we learn how to move non sequentially in texts, the feeling of not knowing where we are will no longer be an issue. Perhaps, too, the notion that one can ever finish a 'book' may disappear with it" (p. 162). She comments that at the moment, we view hypermedia from our skills with traditional print. When we develop equivalent skills with hypermedia, whatever these skills may be, the real value of the medium will emerge.

Communication Processes—Paper and Electronic

As the concept of hypermedia becomes more widely accepted, the questions being asked by researchers have opened the broad concept of hypermedia as a form of communication. It seems reasonable to determine what differences, if any, are inherent to this electronic based format compared to the traditional print familiar to most people. People such as Landow, Joyce, Bolter, Noblitt, Davis, and Shirk explore the rhetoric of hypermedia communication.

The relative ease of producing books with a printing press certainly has had an impact on education. Noblitt (1988) states "the printing press was intended to simply reduce the labor of making manuscripts; no one saw the full implications of what was to come in the field of education" (p. 34). Education, over a period of time, developed into what has endured until today—a book based approach supplemented by teacher lectures. "The printed book gave rise to 'compartmentalized knowledge' through its ability to isolate typographically the visual

sense and to maintain the illusion of textual coherence" (p. 35). Landow (1992) asserts "linear habits of thought associated with print technology often force us to think in particular ways that require narrowness, decontextualization, and intellectual attenuation if not downright impoverishment" (Landow, p. 81).

Those of us using traditional written communication as a natural part of our life tend to simply accept without question the value and restrictions placed on print material. Certainly, as McDaid (1991) points out, "writing is the reification of linearity, of tracking down, of hierarchizing. It is the formulaic *beginning-middle-endness* of writing that we invented if for" (p. 451). Writing in a paper format "the text was *linear*, *bounded*, and *fixed*" (Landow & Delaney, 1990, p. 3). As books became the norm rather than the exception, the resulting "to see the end of the book as the end of the text" (Bolter, 1991, p. 86) attitude provided unexpected influence on ones view of what writing conveyed.

Writing in an electronic environment manifests some basic changes to the concept of writing. "Historians point out that new technology is introduced with the aim of increasing productivity in some form of human labor" (Noblitt, 1989, p. 32) However, "these new modes of expression and understanding will not be absorbed immediately into conventional use, although they offer modes of representation that are possibly more similar to the working of the human mind than are the spatial arrays afforded by pages and pages of paper" (Hooper, 1990, p. 14). To make the transition to electronic writing possible "hypermedia must develop its own set of rules if we are to determine where it fits into the educational picture" (Semper, 1990, p. 67). At this point, "the first efforts at applying a new technology are modeled on strategies used on old technologies" (Picher et al., 1991, p. 37). Changes are slowly emerging.

Many would argue that hypermedia is a more natural activity for people than was writing in a print environment. "Resist the temptation to argue that students should understand traditional ways of doing things first. . . . Hypertext more closely approximates the structure of thought in our minds, or the pattern of thought in our minds, than does conventional text" (Slatin, 1991, p. 62). To accept this idea it is necessary to "embrace the paradigm of

information organized in gigantic interrelated webs" (Shirk, 1991, p. 191). To move from the comfort of print presentation "initially leads students to think of hypertext as the chaotic and random presentation of information. . . . But soon students begin to think more globally about carefully structuring their material and about their learning objectives in presenting it" (p. 191). Writing in hypermedia formats "truly combines so-called product and process approaches" (Davis, 1989b, p. 2).

In education "tradition composition instruction . . . has assumed that almost everything about writing can be taught . . . but research and many teachers' experience suggest otherwise—that very little about writing can be taught directly" (Davis, 1989b, p. 3). The transitions and connections to be found in any writing are hard to convey to learners. "If linear and hierarchical structure dominate current writing, the computer now adds a third, the network as a visible and operative structure" (Bolter, 1991, p. 113). Hypermedia writing allows insights into communication not available in print. "It can allow student writers to see 'behind' finished documents to the process that produced them. " (Davis, 1989b, p. 7). The ability to place the connections at a visible level and to model the process of revision could improve the learner's ability to develop effective communication skills.

Connections form the basis of verbal communications and one defining feature of hypermedia. Electronically one can display the associations the mind identifies by linking the material perceived to be connected. "Electronic writing is a highly associative writing, in which the pattern of associations among verbal elements is as much a part of the text as the elements themselves" (Bolter, 1991, p. 59). "Linking one block of text to myriad others, destroys that physical isolation of the text, just as it destroys the attitudes created by that isolation" (Landow & Delaney, 1990, p. 13). Expert readers do reach beyond the immediate text and "the computer simply makes explicit the implicit act of deeply informed reading which unlike casual reading is truly a dialogue with the text" (Bolter, p. 118). "In the computer, writing in layers is quite natural, and reading the layers is effortless" (p. 15). In

theory at least, hypermedia provides a natural interaction with ideas that are often unavailable in a rigid print presentation.

It would be unfair to assume that hypermedia should replace all forms of written communication and be accepted as the only correct approach to this particular activity. Davis cautions that "we should simply become familiar with the medium, for if hypertext isn't the future for written communication, it is undeniably a future" (Davis, 1989a, p. 5). Hypermedia is already part of our world and "it seems clear that hypertext is indeed better in some cases . . . but for many potential hypertext applications, the disadvantages will be larger than the advantages" (Nielsen, 1991, p. 12). Shneiderman et al. (1991) suggest asking the following question.

> Is this knowledge base suitable for hypertext implementation or is it better implemented using conventional print papertext? . . . The printed page is an excellent high resolution display, capable of presenting large quantities of text with color graphics. Hypertext . . . offers rapid dissemination, potentially lowered production costs, protection against information overload, possible lower cost, and true multimedia (including animation, speech, audio, and full motion video) (p. 144).

These researchers state using hypermedia effectively means carefully considering the goals and situation for its use. If hypermedia does not help to meet these goals effectively, then it may not represent the correct choice of tool for the job.

The act of writing and reading are complex activities. "Writing with pen and paper is no more natural, no less technological than writing at a computer screen" (Bolter, 1991, p. 37). In either situation, "the value of technology is ultimately determined by the use made of it" (Noblitt, 1988, p. 33) Noblitt cautions "every cure [for educational problems] has the inevitable unforeseen side-effects. . . . The popular media have adjusted length of exposure to a decreasing attention span. . . . It is discomforting to imagine that our general education curricula could devolve to a similar fragmented state" (p. 33). Hypermedia is different. It will produce some changes in education.

The process of adjustment takes time. "Each new technology must find its place in the current economy of writing and in doing so it may supplement or replace older technologies"

(Bolter, 1991, p. 39). Gaines (1990) expresses a broad view of combining hypertext with other available technologies. The research being conducted to increase the application and value of expert systems is providing new insights into the way people interact with information. To create an expert system, researchers have learned a great deal about how experts in a specific field use and associate information. Gaines concludes "research on rapid prototyping for expert systems is analyzing the knowledge transfer processes of humanity and will change the foundations of our educational system, our understanding of ourselves, and eventually our culture and modes of living" (p. 437). The printing press changed our view of information. What changes are implied beneath the power of hypermedia?

Communication With Sound and Images

A number of powerful techniques are available in hypermedia systems which require relatively little technical skill to be utilized. Sound, still images, and video pictures can be included with a minimal of effort. However, "there is no sense in using a technique only because it is available; rather it must be an essential contribution to the presentation of the material" (Shirk, 1991, p. 196). Taking advantage of the richness of hypermedia communication systems requires skills beyond the usual understanding of traditional text forms.

Sound is a powerful form of communication in our world and the use of sound is a natural part of our daily communication system. In a hypermedia format "intelligent use of audio can completely alter the way a viewer perceives a program" (Osborn, 1990, p. 361). If chosen carefully, "sound can be a substitute for text, or you can consider sound simply a different form of text" (Campbell & Hanlon, 1990, p. 270). But sound can also be intrusive in the learning situation.

> If you do not like an image, you can ignore it. If you do not like a sound, it will drive you to turn off the computer. . . . We found that users wanted the capability of turning

> the sound on or off. This was especially true if users were going to replay the composition. (Ambron, 1990, p. 82)

Sound forms available "are speech, music, and natural sounds. In some cases the speech and natural sounds serve as entertainment or illustration; in others, the sounds carry information" (Nicol, 1990, p. 152). Before selecting sound, one must consider what purpose it serves in communicating the message being conveyed.

Most users have considerable skill communicating in both oral and written text forms. Guidelines for using sounds in hypermedia documents are presently evolving. "Don't have sound exist in isolation. . . . When you have sound, be sure to have an appropriate card on the screen, possibly graphics related to the sound, illustrating it or identifying it" (Campbell & Hanlon, 1990, p. 270). Alty (1991) explains:

> Using both visual and audio channels simultaneously to explain a complex diagram is better than using only one channel. . . . Whilst audio information seems to stimulate imagination, spatial visualization is better handled visually . . . and diagrams are better at conveying ideas where text is better for detail. (p. 33)

After deciding that sound is the correct tool "the author must decide up front which 15 second 'sound-bites' are sufficient to convey certain information, and whether other sequences require more" (Picher et al., 1991, p. 40). Sound demands considerable storage space. The user must make decisions of space versus communication with sound.

Since the linking of information is one major key to effective hypermedia communication, sounds present a strange dilemma. "The listener cannot click on the musical note sounded . . . so the developer must provide a visual representation of the sound that provides appropriate opportunities for linking" (Picher et al., p. 44). Sound can cue associations and Campbell and Hanlon (1990) use the "sound as the bridge, a link when you move from one idea to another" (p. 270). These writers suggest the two concepts complicate the presentation of information. The designer is challenged to connect the sound to a meaningful symbol and to find a sound that can add to the ideas under consideration.

Images present similar difficulties for users. However, the experience of Hooper (1990) in using *The Visual Almanac* with a variety of groups provides some refreshing

comments. "Although few of us are trained to produce images, most of us are visually and acoustically sophisticated" (p. 18). When given the option "teachers and students are strongly drawn to this image resource and quickly master the required methodology to become expressive multimedia [hypermedia] composers" (p. 19). From her observations she concludes that "most people seemed to have both the talent and the inclination needed to put together their own materials" (p. 19). When you consider that much of today's world is entertained by television and movie presentations, this may be explained as "readiness of the culture to work directly with images" (p. 19). One needs more than desire, however, to use images effectively.

In much the same way that care in selecting words maximizes communication, the choice of images requires attention. "Just as the use of a dictionary of words doesn't guarantee a clear picture of writing, so the use of a multitude of images doesn't guarantee the coherent communication of an idea" (Nanny, 1990, p. 89). Having "the right piece of an image at the right time can have a profound impact" (Semper, 1990, p. 55). Selecting the right piece is the challenge.

Consider the advantages inherent in graphic information. "Dynamic elements attract more attention than text and still images . . . that is, moving images, music, and sound effects" (Ambron, 1990, p. 83). When users are browsing material being presented as hypermedia "they will scan for visuals that communicate ideas with a minimum of time invested" (Nanny, 1990, p. 88). Visuals which convey information at several levels would have an advantage. Nanny suggests that a message available at a glance is a good start but says "not all images are created equal. Some are naturally more compelling . . . images that expand the viewer's point of view" (p. 87). Images that draw the reader back to the node are more effective overall.

When the images have been selected for use, their organization is yet another difficult decision. Florin (1990) provides a number of suggestions.

> Clusters of tightly interconnected materials focused on specific topics are more satisfying than thin layers of data covering broad subjects. For example, isolated pictures are not as interesting as sets of five or more, where each picture in the set adds meaning to the others, exposing relations hidden in the single shot. . . . In most cases, pictures without good captions or data are not very useful. . . . Still pictures and text

> can often be perceived as lifeless unless they are combined with sound or motion footage. (p. 35)

His suggestions are echoed by others. "If a card contains an image, it is usually a good idea to use some text as well, even if it is just a title. The title helps orient the user, giving the user a context for the images and graphics. . . . Some variety in your choice and placement of images adds interest" (Campbell and Hanlon, 1990, p. 268). The hypermedia document can become "a series of graphics than can be examined in greater detail by clicking on parts of the picture. The text of the paper is tied together by the pictures (instead of the other way around)" (Hofmeister, 1990, p. 205). Images aren't incidental—they have the power to direct the communication process.

One of the greatest advantages in using moving pictures is to provide instruction on concepts that have to this point been shared only with great difficulty.

> Images will become the basis for understanding concepts that were previously relegated to complex verbal descriptions. These images will also alter our relationship to information in the information age as they become the key element in helping us take in and understand more information more quickly. (Nanny, 1990, p. 98)

The study of concepts that occur over space and time fit into this category of concepts. Nanny (1990) suggests that the "visual images will provide the concrete examples that lead to greater understanding" (p. 90). She provides the following examples: (1) control location to change perspective—various views of a ball being rolled on a turning merry-go-round, (2) control the size—present a view of things that are normally too small or too large to view such as the eye of an ant or a redwood tree, (3) controlling time—replay what has happened and in effect place past/present/future into one sequence, (4) rate at which something moves—process allows one to watch an event in compressed or expanded time such as the flight of a hummingbird or the hatching of birds' eggs. None of these concepts is readily accessible for study in traditional print formats, yet these all represent common events in our world—events that should be better understood with the aid of hypermedia presentations.

Hypermedia applications such as *HyperCard* offer another unusual application of visual information. The visual effects available to be used as one traverses a link are a new

tool for most people. This element of visual communication is used by filmmakers to assist the transition from one scene to another and to heighten the impact of the change. "Students like 'visual effects' . . . as a quick way to get a sense of movement and animation" (Nicol, 1990, p. 151). *HyperCard* offers "visual effects which can convey additional information" (Nicol, 1990, p. 151). The user might use *wipe left* to convey the feeling of linear movement and *dissolve* to indicate movement to a new concept or idea. By being consistent with the choice and placement of visual effects, the user is aided in navigation and in understanding content.

The visual effects available in hypermedia systems provide an aid in navigating the system. These "visual cues at each card can orient the user" (Oren, 1990, p. 130) if their application is kept consistent. The designer of the system must "manage these transitions carefully, maintaining a feeling of continuity while not limiting readers' flexibility. Since a reader might 'cut' between nodes in a totally unpredictable order, it might be hard for an author to decide how to implement transitions between nodes" (Picher et al., 1991, p. 41). Personal experience would indicate the students frequently over-use this feature and create effects that detract from otherwise effective communication.

Users of hypermedia are used to visual effects from their exposure to movies and television presentations. In the movies "a series of short, choppy sequences are used . . . to move the story along in a sprightly, up-beat fashion. Longer, slower sequences can be more thoughtful" (Picher et al., 1991, p. 40). The use of *fades*, *wipes*, and *cuts* adds to the tension or mood. Picher et al. suggest that frequently the addition of appropriate music to the screen presentation adds information by helping the user connect the present experience to previous situations. As students become involved in more sophisticated hypermedia systems, they will need to extend their skills to include video production.

One visual component of hypermedia is the use of 'icons'. "Icons . . . are [the] computer's original contribution to our writing system. Although an icon may have a name, it is above all a picture that performs or receives an action, and that action gives the icon its meaning" (Bolter, 1991, p. 51). The selection of "icons, stylized easy to understand images to

communicate potentially available actions or subject matter" (Shirk, 1991, p. 196) provided considerable discussion among her students. Shirk's students were attempting to create a *HyperCard* stack that would serve to teach a specific concept. Their comments indicated a concern that although an icon potentially communicates a great deal of information, selecting icons was extremely difficult. The variation in peoples' perception of visual images created problems.

Icons alone are not always effective. The author may need to include other cues for the user. "Some icons will suffice without a written explanation, while others may need one" (Stanley, 1992, p. 27). Authors' must carefully consider their icon selections. User disorientation is often a result of an inconsistency in what the icon implies and the actual resulting action when the button displaying the icon is used. Picher et al. (1991) suggest "the active areas (link anchors) might be highlighted by coloring them differently than the background, by outlining them, or by using a 3-D effect that displays the image of the link anchor" (p. 44). In this way the visual cue becomes part of the action information. In electronic space, "icons . . . tie together elements in the computer's writing space. . . . They show how documents are grouped, and they connect documents to the program that creates them" (Bolter, 1991, p. 51). Icons are a convenient and powerful communication device in electronic presentations.

Giving students the power to include both sound and images in their assignments increases the number of skills they need to develop. It is prudent to consider if the value of their use compensates for the extra demands of the learning. Both sound and graphics change the manner in which a learner can and will interact with given information.

> Current research indicates that emotion is not only involved in memory but is also the basis on which our memory is organized. . . . Image recall is our most reliable and generally accessible memory, and moving images and sound are a particularly effective way to illicit emotion. (Koetke, 1990, p. 353).

Hypermedia provides "direct methods to combine sound, symbols, and images with thinking, doing and feeling" (Noblitt, 1988, p. 62). But "researchers can correctly point out that we

don't even know for sure whether exposure to external images is the most effective way to create internal images" (Koetke, 1990, p. 355). Koetke provides the example of people seeing their own image in an event they are remembering as an internal picture. The person recalls the event in a way impossible to experience. Despite these doubts, the environment of hypermedia makes learning possible in new and unusual ways.

Examples of Hypertext Environments

Intermedia

Intermedia represents an early venture into the use of hypermedia at the university level. The Institute for Research in Information and Scholarship (IRIS) at Brown University developed a corpus of material designed specifically to be used with the humanities. Intermedia is discussed to illustrate the ability of a hypermedia system to play a role in a number of contexts. Documents that are brought together for some purpose may indirectly play a role in a situation not anticipated when the document was first designed. The context in which the system is used provides considerable influence on how the material is viewed. The Intermedia system takes advantage of the integrated nature of hypermedia presentations.

The Intermedia system incorporates extensive information. One portion known as *Context32* in 1989 already exceeded 6,700 documents of various types. As students interacted with the system, student documents and links were added, increasing the amount of available information in the system. The *Context32* began its use in English classes but was incorporated into other programs as well.

Landow explains that the materials in the Intermedia system were developed by non-programmers and are intended "to help students read with greater skill and pleasure" (1989, p. 351). Students can:

> Create links as part of their regular work with spreadsheets, word processors, graphics editors, or other media. . . . A framework for a collection of tools that allow authors to make links between standard types of documents created with heterogeneous applications. (Yankelovich, Meyrowitz, & Van Dam, 1991, p. 72)

Any of these applications can create a document that can be viewed in a window accessible via Intermedia. The materials are used as supplementary resources to the regular reading assignments. Landow observed that the effectiveness of the system depended quite heavily on the manner of introducing the students to the system and the choice of assignments created to take advantage of the system.

Intermedia provides "study guides and questions to individual works, summaries of state-of-the-art scholarship, introductions to basic critical concepts and original scholarly and critical contributions" (Landow, 1989, p. 352). In addition, the system allows documents of graphic form such as digital representations of paintings, photographs, and maps. Intermedia includes "graphic representations of literary influence and interrelations that take the form of diagrams of vector forces . . . emphasizing unidirectional flow of forces" (p. 352). This allows Intermedia to model the connections in the material and "accustom students to think in terms of multiple connections and multiple explanations" (p. 356).

Intermedia is a very large collection of electronic material. A number of features are included to encourage the student to explore the material easily and to help keep the user oriented in the overall picture. One method is to "surround a particular phenomenon . . . by a series of topics and issues that relate to it" (p. 356). This provides a type of concept map that helps students visualize the connections.

A unique concept in the Intermedia environment is the webs that are available for immediate use. These webs provide a suggested network of material that can be perused for a particular topic. The system can generate:

> Diagrams of the information web at different levels of detail. A *global map* . . . shows links at a document-to-document level. A *tracking map* provides continually updated view of the currently active document its links and has four levels of detail . . . (1) document to document, (2) document to block, (3) block to document, (4) block to block. (Yankelovich et al, 1991, p. 74)

A block (or actual site of the electronic connection) view moves the user into the most detailed presentation of their particular web.

Intermedia, like all true hypermedia systems, allows numerous pathways. "Readers choose different reading paths, but it also allows . . . creating alternate assemblage of links or webs as they are termed in Intermedia" (Delaney & Landow, 1991, p. 35) With this flexibility for webbing, Delaney and Landow comment that the material can be used to create contextual webs suitable for a number of purposes. Thus, the biology, literature survey, renaissance cultural history, and nuclear arms and arms control courses can all use the corpus of material by meeting it in a context tailored to their perspective.

Intermedia represents a truly collaborative environment. Since "any document placed on a networked system that supports electronically linked materials potentially exists in collaboration with any and all other documents on that system . . . any document electronically linked to any other document collaborates with it" (Delaney & Landow, 1991, p. 15). In a more immediate sense the networking of the individual work stations implies "that any addition or change to a document is instantly available throughout the system" (Landow, 1989, p. 35).

One of the many valuable tools included in Intermedia's features is the access to resources such as a thesaurus or dictionary. "These reference works are among the most heavily used Intermedia facilities" (Yankelovich, 1991, p. 138). Students indicate that the ability to search quickly for a particular word or derivatives and expansions of the word make this factor particularly useful.

The English courses using the *Context32* material are designed to provide the students with an introduction to a wide range of authors. But the goals also include more ambitious ones as well. It is intended that the course "enable students to describe the interrelations of authors, broad movements, and various extra-literary cultural contexts, including those provided by social, religious, political, intellectual, artistic, and technological history"

(Landow, 1989, p. 351). The consensus of the IRIS group indicated they felt Intermedia was helpful in achieving these goals.

Guide

Guide is included to illustrate the power of hypermedia presentations to illustrate a specific theory of writing—intertextuality. The concept of intertextuality of writing emphasizes that belief that all writing can be considered to be directly built on previous material. For example, to fully appreciate the contents of the literature review, the reader would need to consult the writing of the authors mentioned. The content of their writing is influencing and playing a role in the development of this particular document. No written document exists without some context to add to the meaning of the information.

The hypermedia environment *Guide* provided, allowed students to gain considerable understanding of the theory of intertextuality. Written works are considered to be intertextual since the present work gains meaning partly from what has been previously written. *Guide* allowed students to apply their understanding of intertextuality by creating a hyperdocument that illustrated their interpretation. Using the electronic linking ability of *Guide*, connections between the more recent material and previously written works could be made visible and easily accessible to the reader. By locating the underlying material to the present work and justifying the association, students could understand the way layers of information are combined. Using *Guide* a combination of a theoretical and a practical approach to a complex subject might help students achieve greater levels of understanding than traditional approaches to the same topic.

Researchers at the College of Wooster have been testing the use of hypermedia in a course entitled "March 2, 1667." Havholm and Stewart (1988) began their study by assuming that hypermedia had the ability to "create simulations of the theory of intertextuality as it applies to specific seventeenth-century texts" (p. 1). Using OWL International Inc.'s *Guide*,

students were asked to "simulate intertextuality at a specific time with specific texts" (p. 10). *Guide* was selected because "its use on a Macintosh is quickly taught, both the program and its products are economical in their use of disk and memory space, and the program is text based" (p. 8).

Havholm and Stewart (1990) provide some interesting observations from their unique class setting. They explain that the "theory of intertextuality contends that all texts are formed from previous texts" (p. 9). Viewing any example of writing from the point of view of this theory provides an unusual challenge. "Intertextuality implies a three-dimensional view of texts. It suggests not just links but a metaphor in which many texts are 'beneath' or 'behind' any individual text" (p. 9). Since hypermedia provides the tools to layer text with relative ease, *Guide* empowered the students to "make a model of the theory's application rather than talk about it" (p. 10). In their hypermedia environment, students "learned and mastered the ideas, and along the way the intellectual self confidence and skill to criticize the theory" (p. 10).

Havholm and Stewart identify a number of immediate activities and directions for student study which emerged from the project. "The first concerned earlier texts. Students were forced to become acquainted with seventeenth-century culture in a deep and detailed way" (1988, p. 11). This demand promoted considerable cooperation among students as the responsibility was shared and each person became the expert in some area. Each student produced material that was added to the library of available text.

Havholm and Stewart (1988) continue their report saying "the second line of questioning concerned the theory itself" (p. 11). The students were required to make some critical decisions regarding what could be classified as underlying text. Many debates resulted in the recognition that underlying text would by necessity predate the original and "texts being discovered might not be thought of as the underlying texts but as simply representative of such texts" (p. 11). The class recognized that any relationship between the texts was something that could be argued. One could argue the choice of the text itself and the position of the text being placed underneath.

The third direction of students' questions arises from the simulation of intertextuality using hypermedia.

> Students create their own simulations, they do not use those created by others. To do so, students had to clarify their own assumptions, make reasoned judgments, argue for those judgments, revising them when necessary, and determine clear and appropriate ways of modeling those judgments. They had to understand, question, test, and adapt a theory that, so far as we know, has never been modeled before and probably could not be without the use of hypertext. In sum, students had to think critically and to understand what critical thinking meant. (Havholm & Stewart, 1988, p. 14)

During the course, students moved beyond the demands of critical reading to a new level of understanding achieved previously only with great difficulty.

Project Emperor-I

Project Emperor-I is discussed to illustrate the richness of the learning environment available when technology is used to bring together a vast collection of material on a specific subject. The ability to interact with the material in a variety of ways demonstrates the power of creating a hypermedia or multimedia presentation with a single database versatile enough to meet multiple needs.

This project shares with learners an amazing collection of information about "the First Emperor of China, his imperial past and his incredible terra-cotta army of warriors and horses excavated in 1973 near the ancient capital of China, Xian" (Chen, 1989, p. 10). Original archival materials and film footage of the excavation at Xian were provided by the Chinese government, and interviews with leading scholars in the field have been included. The project was "intended to bridge the gap between the East and the West, the past and the present, humanities and high tech, and scholarship and applications" (p. 11).

The study of humanities is difficult to teach. Chen (1989) points out that in the western world, lessons on the topic of China's first emperor tend to rely heavily on lecture format, a few slides, and whatever print matter can be located. The blend of technology and information in this project allow some changes.

> For the instructors, direct access to quality still and video pictures can bring new life to subjects that are generally difficult to teach. In addition, the diversified and broad range of subject areas available can encourage the analysis of single situations from many different perspectives, particularly when different views are expressed by subject experts through either interviews or their publications. (p. 57)

Access to the "world's most renowned specialists on the topic reside in China and are not generally accessible to the Western specialist and students" (p. 14). One of the immediate outcomes of the project was the global sharing of an archaeological wonder of our times.

In a few brief months work, *Project Emperor-1* was able to release two videodiscs of material.

> Each two sided videodisc contains 108,000 frames of visual images, one hour of audio track with narration and/or interviews in both English and Chinese, and authentic musical interlude. The first disc includes over 200 segments of motion video from films and videotapes and about 5000 still frame slides. . . . The second disc is essentially an oral history disc, including interviews with ten of the world's top most experts on the subject. (Chen, 1989, p. 13)

The release of the two discs gave access to vast quantities of material valuable to anyone interested in the study of China's first emperor. However, the material needed some way to effectively control the presentation and maximize the use of the discs' content.

The full power of the product began to emerge in 1988 when the group decided to use *HyperCard* as a computer interface to control and determine interaction with the database. It took only two brief months to "create a project modeled after an extensive two-semester graduate study course outline" (Chen, 1989, p. 14) from Harvard University. Chen's group realized that *HyperCard* provided "a true seamless environment where a system user could gather and link information easily from different storage media and sources to obtain his or her own desired information package" (p. 14). The ability of hypermedia to facilitate the use of a single database for many different types of users with a variety of purposes moved the project in a new direction.

This hypermedia product meets the goals designers desire in educational applications. Chen describes their program as containing two separate built-in courses. One course is designed for the general public to pursue while the second is a research based approach for the

serious student and scholar. Chen points out the added dictionary feature. "Instead of a monolingual dictionary, a bilingual dictionary became a reality" (p. 54). The user could switch the system at will from English to the Chinese language. With hypermedia's ability to layer information, the development group recognized "certain Chinese classical texts are essential to the understanding of the subject. . . . A bilingual presentation of important historical text" (p. 54) was made accessible. Search features for a variety of goals provide the user with the independence of finding the information they personally desire to use.

The potential of this product has not yet been fully realized. Chen, at the time of writing the article (1989), realized that with the fast developing technology available, the original information could be given even greater emphasis in education. "*Project Emperor-I* demonstrates . . . new technology can indeed be used to promote better general understanding and appreciation of the humanities. It also introduces a new interactive educational and learning model" (Chen, p. 11). With the power of hypermedia tools one can:

> Effectively present and interpret a stunning art history subject, can provide immediate information access on a difficult topic despite the various barriers such as time and geographical distance, and can permit the free and immediate exploration of the fascinating ancient treasures which otherwise could only be viewed on site. (p. 11)

As an example of the potential for the world to provide meaningful access to knowledge and artifacts that cannot be transported to other locations, *Project Emperor-I* sets a high standard for others to follow.

Galileo

Discussion of the Galileo project is presented to illustrate the opportunity to incorporate hypermedia systems to advantage with minimal expenditure. This electronic library presentation includes only the most basic of hypermedia features. There are no predetermined links in the material and associations must be recognized by the users. But, the

ease of interacting with the material in an electronic format provides students with a valuable tool.

The Galileo project is an attempt to learn something about the value, if any, of university students making use of an electronic based library. An attempt was made to "integrate the power and flexibility of available full-text technologies . . . and offer undergraduate students in the humanities easy access to detailed, high-level scholarly work" (Friedman, McClellan, & Shapiro, 1989, p. 243). These researchers assembled an electronic version of sixteen complete books and numerous scholarly articles by and about Galileo, the famous seventeenth century scientist, to supplement traditional course reading material. "Textbooks and other reference materials were also available on the reserve shelves of the library and students bought course texts as usual" (p. 245). The investigation focused on integrating the electronic library into an otherwise conventional classroom situation.

Friedman, McClellan, and Shapiro (1989) used the electronic database for three different courses. One course was a semester long class devoted to Galileo and the scientific revolution—a course taken by science and engineering students at Stevens. The second application of the database was for freshman enrolled in an introductory history of science survey class with a two week unit on Galileo. These two classes were conducted at Stevens where each student has a computer and the campus network connects computers "in all academic facilities as well as dormitory rooms" (p. 245). This factor gives Stevens students an opportunity to accept technology as a natural tool to assist their learning.

The final test site was selected to provide the opportunity to work with students less conversant with technology. For this purpose, the Galileo database was shared with a group of Drew University students. These upper-level liberal arts students were taking a history of science class which could be supplemented with the Galileo database. These students "from a variety of majors, were all talented, but had limited computer experience" (Friedman et al., 1989, p. 252). The experience of these students with the database was very positive and encouraged the researchers to believe their approach had value.

One major limitation in the Galileo database was the lack of imposed organization on the material. "A fundamental decision made at the outset of this project was not to impose any pre-established links between and among the materials entering the Galileo database" (Friedman et al., 1989, p. 245). The authors did not want to impose their interpretations of the text on the students. Because the material was unlinked, the students were free to explore the material as they wished and establish their own conceptual structures.

Personal Librarian, the software selected to interact with the database, has a powerful feature for search and find tasks. The software has the ability to "search for more than one word at a time, and it is possible to search for one keyword within a specified distance from another word" (Friedman et al., 1989, p. 246). The expand feature "suggests other words related to the keyword chosen" (p. 246). When the expand/find feature is activated, the nonlinear linking in the system results directly from the search chosen by the user.

Despite the apparent appeal of the expand feature, the authors of this article indicate their disappointment over its lack of use by students. The links and connections suggested by this ability of the software were under used, possibly because "students did not have sufficient familiarity with the function, and with the enlarged database, the time required to execute the expand function proved to be an obstacle" (Friedman et al., 1989, p. 246). Although some students used the feature to locate database connections, most associations were created by the students' own thinking.

Assignments were designed to have students take advantage of the database. Students were asked detailed questions about the readings, were required to write term papers, and were continually encouraged to browse. During the course of the year, instructors "noted more pointed, analytical, and detailed results in student papers, as compared with the often-times superficial work done by past students. . . . In addition, use of the database carried over into class reports" (Friedman et al., 1989, p. 250). "Students were able to comment more critically and help guide their classmates more than is ordinarily the case" (p. 251). Teachers indicated feeling quite rewarded by the experience.

Student reaction was interesting. Student commented while "it was difficult to keep track of what document they were reading . . . they (65%) felt that they gained access to more material using the electronic material than using hardcopy" (Friedman et al., 1989, p. 251). Friedman et al. indicate that a number of students reported using the database for browsing.

> Students reported that they sat at the workstation, tried out different searches, skipped through different parts of the database, and/or read the database as one would a book. They said this in spite of the fact that the computer screen did not reproduce the corresponding printed page in full and in spite of our preconceived notions of the inherent difficulty of such browsing. (Friedman et al., 1989, p. 251)

The authors of this study listened to the comments students shared and from their students "the lesson that emerges is that for all users to get the most out of the database, the system must be extremely easy to use" (p. 253). This comment is made by students who accept and use technology. For students less technically competent this cautionary note may be more critical.

The authors note that "the mere impression of difficulties discouraged some users" (Friedman et al., 1989, p. 253) but "results were favorable overall" (p. 248). "We think that the open-ended and unstructured nature of full-text databases and related search software offers students greater independence in exploring new material than comparable hypertext system" (p. 255). In addition, this hypermedia approach represents a truly economical approach that may serve as an entry level for many users.

Reactions to Examples of Hypertext Environments

Each of the preceding examples of hypermedia applications demonstrates a separate strength of the medium. The Intermedia application used for research at Brown University quickly demonstrated the ability of hypermedia products to be used in several settings. From the large base of information included, it is the context and purpose of interaction with the information that determines the concept the reader gains from the exercise. The effort required to produce the product for one use may in fact spread to several equally valid uses not recognized at the outset.

The experiences of Havholm and Stewart provide a different perspective of the value inherent to hypermedia. Their work demonstrates that the concept of a theory such as intertextuality can be provided while allowing the learner to become aware of the construction of the theory. Students with an opportunity to actively interpret and illustrate their understanding of a complex theory such as intertextuality are given a chance to understand the concepts at a level beyond that achieved in traditional settings.

The *Project Emperor-I* illustrates to the reader the potential in hypermedia at the upper level of quality. To best display the photographs, films, and color included in the system, the technology required may be beyond the price range of many educational settings at this point. The potential, however, is certainly evident. In contrast, the Galileo project demonstrates a way for hypermedia to benefit learners when available funds are limited. Galileo lacks the images, sound, and extras that makes *Project Emperor-I* so exciting, but student response is still positive. Students still express a satisfaction in working with information in electronic form as being a faster and easier task than similar tasks in traditional forms.

Learning—General Comments

Jones, Palinscar, Ogle, and Carr (1990) discuss the concept of learning. Education intends that students should learn and researchers have expended considerable time and energy to determine just what is meant by the term. The following six points represent the concept as understood by researchers in the field at this time.

> Research based statements about learning: (1) learning is goal oriented, (2) learning is acquiring a repertoire of cognitive and metacognitive strategies, (3) learning occurs in phases yet is nonlinear, (4) learning is organizing information, (5) learning is linking new information to prior knowledge, and (6) learning is influenced by development. (Jones et al, p. 4)

These six statements reduce a very complex idea to a fraction of its content but provide an excellent position from which to consider the hypermedia tool. If hypermedia is able to help

educators meet the conditions listed, then perhaps it provides another viable option to be utilized in the effort to help students learn.

Novak and Gowin (1984) consider some of the aspects of learning. "To learn meaningfully, individuals must choose to relate new knowledge to relevant concepts and propositions they already know. . . . Rote learning may be acquired simply by verbatim memorization . . . without interacting with what is already there" (Novak & Gowin, p. 7). In many situations the learners need to create their own understanding of the concepts. "Asking students to prepare concept maps to report on literary readings means they must not only read a work, but also make some conceptual sense out of it" (p. 46). Hofstadter in Godel, Escher and Bach (1985) explains that to have a concept be of any value, the information needs to be connected (in the mind, in the memory) with other pieces that can also be thought of as concepts.

Concepts are created with interaction on prior information. However, the student's previous experiences have a role in this task. "This prior experience shapes the amount of time and effort that will be invested in a problem. Prior experience will determine what information the student thinks is relevant and what concepts the student thinks are appropriate" (Schoenfeld, 1989, p. 341). Much depends on the learner's attitudes and goals.

> True learning means to adopt an attitude of striving to integrate your mental skills toward the end of achieving competence *and quality* in what you think, say and do, and to continue to be open to broadening your perspective and understanding of the world around your. To develop as a student means to be open to the *process* of learning, as—perhaps even more than—to the results. (Ramsland, 1992, p. 11)

Learning is an activity that requires a great deal of effort to be accomplished to a high level of competency.

Learning with Hypermedia—Special Issues

Authoring

Students traditionally produce a wide variety of assignments to demonstrate their learning. Writing skills have always been a dominant component of these products. In hypermedia, the value of having students produce a hypermedia product is also critical. Researchers and teachers have observed that students seem to gain a great deal from authoring a *HyperCard* stack designed to share some particular topic. "When a person dwells on a concept and considers how to present it well, the concept will probably be understood when it is presented" (Hooper, 1990, p. 15). "Students were able to develop ways of explaining very complex concepts" (Stebbins, 1990, p. 20) with the flexible tools hypermedia provided.

Assignments done in *HyperCard* illustrate that students do seek a wide variety of research material. Many students comment "I have about ten references on my topic. I was looking for a picture to include and now have several. Had I been just writing my assignment like normal, I would never have bothered with anything but the textbook" (Smith, 1992b). A student preparing the information for her stack commented "I just realized that this topic isn't English or history, it is both. No wonder I was frustrated with just the book" (Smith, 1992b). As students recognized the ease that associated material could be included, the types of material they brought as information sources became much wider.

The research required by students to produce quality stacks varies little from traditional research assignments. Landow and Delaney point out that students still need to develop the skills to formulate the questions and then investigate the context and connections related to these questions. These authors remind us that the critical thinking skills needed to relate many things together are as important in hypermedia as they ever were. However, in their experience students do work on continual synthesis of material and no longer focus on what is required for test day.

Collaboration

Collaboration is available in hypermedia in a manner not previously found. "A group of people *cannot* simultaneously write and read from the same piece of paper but can simultaneously write and read the same page of the text on the computer" (Rada, 1991, p. 668). This creates a situation where "the hypertext essay might well be the work of multiple authors" (Slatin, 1991, p. 59). Landow (1992) comments that the very nature of hypermedia implies that "within a hypertext environment all writing becomes collaborative writing" (p. 88). The on-line environment encourages an attitude of sharing.

Landow defines a number of ways that collaboration occurs within a hypermedia presentation. "The active reader necessarily collaborates with the author in producing a text by the choices he or she makes" (p. 88). That is, the reader collaborates with the author and determines the final form the text at the time of reading. Another variation Landow explains is the "collaboration which appears when one compares the writer with other writers . . . the author who is writing <u>now</u> with the virtual presence of all writers 'on the system' who wrote <u>then</u> but whose writing are still present" (p. 88). The hyperdocument evolves from the ongoing process of having users/writers place their additions into the system

This medium also promotes the blurring of expert versus novice writers—of student versus teacher. "Hypertext . . . allows collaboration not only among those of equivalent rank or status but also among those of widely different rank or status" (Landow, 1992, p. 141). Each writer can contribute without destroying or changing additions or material placed in the system by others. Smith (1992) was told by numerous students that they felt comfortable suggesting changes in an ACCESS stack. They understood the process by which the stack was created and felt they could improve some of the presentations. These same students felt they would *not* be able to contribute material for a printed book.

Landow discusses the concept of collaboration that appear in group situations. The usual approaches to collaborative work are working side by side to produce a final statement.

This means the writers need to be working on the task at the same time. Landow's second model of collaboration is termed versioning. In this approach the writers are not necessarily working at the same time. Instead they edit and revise in turn until a final product is created. The third approach Landow discusses takes a segmentation approach to the work where each person is given specific portions of the task as an individual responsibility. The total sum of the parts creates the final product.

Landow continues by saying that hypermedia offers all of the previous approaches plus another option. In a networked situation, "all additions to a system simultaneously are a matter of versioning and of the assembly line model. . . . A document no longer exists by itself" (1992, p. 89). He discusses including material on nuclear arms by linking into material being used for English classes. "Hypermedia linking automatically produces collaboration" (p. 95). With the advantages of the technical format the system "allows and encourages collaborative work, and at the same time it encourages interdisciplinary approaches by making materials created by specialists in different disciplines work together" (p. 95). Hypermedia provides access to specialized instruction and material that gains meaning from the context in which it is to be used.

Collaboration occurs within informal situations. "Students share various techniques with each other, and the group's project often has been improved through the help of a multitude of 'outsiders'" (Stebbins, 1990, p. 229). Students "begin to realize that individually they do not possess all the requisite skills for communicating in this new medium" (Shirk, 1991, p. 197). Even for professional developers, Olivieri (1990) comments "it is likely that we would discover that the very best stacks are developed through a combination of talents that include teaching experience, subject experience, computer experience, and applications-development experience" (p. 301). This informal exchange of ideas and encouragement which provides the attitude of collaboration instead of competition may be one of the strongest reasons to use hypermedia in educational settings.

Discovery or Exploratory Learning

The use of hypermedia as an exploratory tool is an important one. In working through an interaction with information on their own, "students make choices and reach their own conclusions. This deepens their understanding of the subject, because that knowledge was discovered 'hands-on' and is now *theirs*" (Florin, 1990, p. 47). Based on their experience of classroom instruction, Campbell and Hanlon state:

> It [interactive media] seems to inject a sense of immediacy and reality in a subject that is evident in the way students regard what they are studying. Rather than *telling* students that a subject is relevant or significant, we have a way of helping them to discover that for themselves. (1990, p. 286)

As Hooper reminds us "a critical prescription for learning . . . is that of *active learning*" (p. 15). In a hypermedia product that requires choice and activation of links, the user must remain involved in the process.

Hypermedia presents information without a rigid structure. "The author of the text has set up a number of alternatives for readers to explore rather than a single stream of information" (Nielsen, 1991, p. 3). With the ease of the computer presentation "the computer helped students to make discoveries or to locate materials and connections that they would otherwise have missed or spent a long time searching for" (Campbell & Hanlon, 1990, p. 262). These presentation tools are "encouraging exploration of relationships among various objects of study, and by encouraging students to view those objects from a number of different perspectives" (Slatin, 1991, p. 62). Unfortunately, as mentioned by Grabowski and Curtis, "because these hypermedia stacks leave the attempts to access whatever content or representation of that content up to the learner, it is unclear how much or what type of learning actually occurs" (1991, p. 6). The very characteristic that makes the tool so valuable, makes the outcome difficult to control.

Hypermedia offers each individual interaction of their own choice. Despite this flexibility, hypermedia remains a difficult medium to use. "Exploratory learning offers

increased freedom and motivation to the student. It bears the cost of cognitive load, mental burdens imposed by the task of digesting and organizing information" (Oren, 1990, p. 127). In addition to the challenge of exploration as a learning approach, "hypermedia systems generally impose their own additional cognitive load in the form of so-called 'navigation'. . . . How acute the cognitive load becomes depends on the quality of orientation cues in the database and the number of choices offered at one time" (p. 127). The price for accepting the empowerment is considerable.

Ill-structured Domains of Study

For many subject areas, the isolation of disciplines has created unique problems. Consider the term ill-structured domain. "By '*ill-structuredness*' we mean that many concepts (including contextually) are pertinent in the typical case of knowledge application, and that their patterns of combination are inconsistent across case applications of the same nominal type" (Spiro, Coulson, Feltovich, & Anderson, 1988, p. 2). "Examples of ill-structured domains include medicine, history, and literary interpretation. . . . *All* domains which involve the application of knowledge to unconstrained, naturally occurring situations (cases) are substantially ill-structured" (Spiro, Feltovich, Jacobson, & Coulson, 1991a, p. 26). These domains reflect complexity due to their interconnectedness.

In the introductory stage of learning a new concept, the material may not fit this definition. However, "more advanced stages require the mastery of 'ill-structured knowledge domains' in which concepts are more complex and interdependent, involve significant context-dependent variations, and require the ability to respond flexibly to 'messy' situation of applications" (Jones, 1990, p. 21). "The phenomena of ill-structured domains are best thought of as evincing *multiple truths*: single perspectives are not *false*, they are *inadequate*" (Spiro et al, 1991b, p. 22). These domains require special effort in learning.

Spiro and his colleagues discuss the problems they have observed in learning situations. They identify the following seven common errors learners are prone to make.

> (1) Oversimplification: treating superficial similarities as unifying characteristics and thought of as independent, (2) Over reliance on a single basis for mental representation, (3) Over reliance on 'top down' processing such as generic abstraction versus detailed knowledge in a case study situation, (4) Context-independent conceptual representation: making the information overly uniform, (5) Over reliance on previously learned knowledge structures, (6) Rigid compartmentalization of knowledge components, and (7) Passive transmission of knowledge. (Spiro et al, 1988, p. 4)

These same people offer the following suggestions to correct many of these problems which occur so frequently in ill-structured domains of study.

> (1) Demonstrate the *complexities and irregularities* . . . to clearly demonstrate the intricate pattern of *conceptual combination*, (2) Use multiple representations . . . knowledge that will be used in many ways has to be learned, represented, and tried out (in application) in many ways, (3) Centrality of cases—the more ill-structured the domain, the poorer guidance for knowledge *application* that 'top down structures' will generally provide, (4) In an ill-structured domain there will be greatly increased variability across cases in the way the same concept is used or applied. . . . In ill-structured domains the meaning of a concept is intimately connected to its pattern of use, (5) Emphasis must be shifted from *retrieval* of intact, rigid, precompiled knowledge structures, to *assembly* of knowledge from different conceptual and precedent case sources, (6) Hypertext program guides the learner in criss-crossing the domain's 'landscape' by exploring patterns of overlap....Knowledge representations are built up in which parts of cases are connected with many parts of other cases, (7) Active learner involvement in knowledge acquisition, accompanied by opportunistic guidance by expert mentors. . . . Aids must be provided to help the learner manage the added complexity that comes with ill-structure. (Spiro et al., 1988, p. 8)

This group of researchers are careful to add the comment that "introductory learning 'compartmentalized knowledge, presenting clear instances (and not the many pertinent exceptions), and employing reproductive memory" (Spiro et al., 1988, p. 2) varies considerably from "advanced learning-knowledge being intertwined and dependent, has significant context-dependent variations, and requires the ability to respond flexibly to 'messy' application situations" (1988, p. 3).

Possibly the most effective time to use hypermedia is with complex, ill-structured knowledge domains. For both introductory and advanced learning in a field that integrates context and content, hypermedia provides an effective learning environment. Using a hypermedia system to create assignments "students have a unique opportunity to develop

information retrieval and information processing skills. . . . Producing a mixed media presentation provides new ways for students to demonstrate their understanding and actively participate in a team effort" (Fernlund & Cooper-Shoup, 1991, p. 70). Students can use hypermedia to help convey the complex ideas these domains inevitably contain. Connecting a variety of items to provide a context and support for their ideas makes optimal use of the strengths of hypermedia systems.

In discussing the study of history Slatta (1991) indicates the "presenting history as a series of linear, inevitable events distorts the realities of the past" (p. 201). Slatta goes on to say that "history can show a rich web of interrelationships. . . . It can link people, causes, outcomes, processes, and events across great spans of time and vast geographical expanses" (p. 202). Using hypermedia to study history allows this richness to be viewed in a concrete manner. "By seeing interrelationships between technology, human decisions, and other variables, historians reveal the interconnectedness of past, present, and future" (Slatta, p. 203). Hypermedia helps to convey to students the correct attitude towards the study of history by illustrating constantly that history is not a series of isolated facts and events.

Learners meet and work with ill-structured domains on a daily basis. Hypermedia provides one tool to help students with these domains. For example, Hooper (1990) discusses using hypermedia to present time based, complex phenomena such as cell division in plants or animals. "A critical aspect of understanding time-based phenomena, which encompass most of one's everyday experience, is the ability to control these phenomena directly. . . . *HyperCard* and optical media allow . . . viewers with direct manipulation of complex events" (p. 20). Hooper also presents the example of having athletic events presented with video. In addition to watching the actual performance, the presentation can be viewed frame by frame and analyzed for information. The complexity of these phenomena can be dealt with in ways previously inaccessible to the learner.

This particular application of technology would appear to provide many answers to problems discussed in relation to the category of complex, advanced knowledge. In the struggle for:

> Advanced knowledge acquisition—learning beyond the introductory stage for a subject area but before the achievement of practiced expertise that comes with massive experience . .. the learner must *attain a deeper understanding of content material, reason with it, and apply it flexibly in diverse contexts.* (Spiro et al, 1988, p. 2)

It is possible that hypermedia provides our best learning/teaching tool available. But, "when studying complex systems, the arbitrary breakdown of themes or categories familiar to the designers might not match the users' own mental constructs, no matter how good the editors are" (Florin, 1990, p. 35). Still, the opportunity hypermedia presents for the user to individualize their interaction with the information may be the right choice for many situations.

Integration of Disciplines

The invention of the printing press has influenced the manner in which users view information. The format of the printed book resulted in information being presented in isolated packages to fit the limitations of the book structure. With the rapidly increasing availability of information, "knowledge itself has become our fundamental resource. . . . It is human knowledge that has created the world we live in, including its problems, and it is human knowledge that provides the only available solutions" (Gaines, 1990, p. 435). He continues by stating that:

> Knowledge is unitary—boundaries between materials, processes, devices and systems or between physics, chemistry and biology, are becoming meaningless. Too rigid adherence to such distinctions is an impediment to effective operation in a knowledge based economy. (p. 435)

Gaines reminds us that it is the use of technology that allows one to handle quantities of information without the artificial separation imposed by printed text.

One of the advantages of hypermedia products mentioned by researchers and educators is their ability to show the associations inherent in information. From his perspective as a teacher in an Apple Classroom of Tomorrow (ACOT), Stebbins (1990) says "we try to show our students that each subject complements the others in such a way that each subject becomes far more important than its mere content area. . . . They [the students] will tell you that they are taking ACOT—not math, science, English, and social studies" (p. 226). For classrooms with more limited resources "hypertext offers solid materials in each discipline and the virtual presence of teachers from other disciplines" (Landow & Delaney, 1990, p. 20). An attitude that appreciates knowledge in numerous contexts is enhanced with access to quality resources from connecting contexts.

The material in a hypermedia product can readily draw upon a number of sources. "It allows and encourages integrating all of one's teaching . . . and the emphasis upon connectivity also encourages one to relate all of one's interests at those points that touch upon one another" (Landow & Delaney, 1990, p. 21). The time required to produce the product can be of benefit to all areas the teacher is responsible for covering. The use of the product is flexible and:

> By having related materials available teachers can (1) simply permit students to encounter them [related texts and topics] during browsing, (2) suggest relevant areas students can investigate, or (3) create assignments that model the way a professional draws upon several approaches, disciplines, or bodies of material. (p. 22)

A given application of hypermedia determines what information is given the user's attention. The same hyperdocument may be equally valid in a number of situations.

Hypermedia provides an ease of organizing material that promotes the use of many versions and related pieces of information. One can provide supporting and contrasting views, visual and oral reports, dynamic and static information, all with relatively little complication from the technical demands. "When advanced information is learned using many varied exposures, with no particular sequence, in the context of an occupational setting, the transfer of knowledge to application is more likely to occur" (Hartman & Schell, 1991, p. 48). When

asked, "students also think that good teaching practice consists of showing students lots of different ways to look at the same question" (Schoenfeld, 1989, p. 346). Studying concepts in their contextual settings provides a much needed basis for helping students find relevance in what is learned.

Hypermedia allows both the creator and the reader of the product to actually see the connections in the text. Slatin (1991) says "hypertext more closely approximates the structure of thought in our minds, or the pattern of thought in our minds, than does conventional text" (p. 62). Berk and Devlin (1991) add that:

> The computer holds the data and presents it to the human, the human chooses which way to go by pointing at each juncture. It is an intuitive approach in which the ability to link associated text matches the brain's natural tendency to think associatively. (p. 10)

The original context of linking material is found in the classic article of 1945 written by Vannevar Bush.

> Man cannot hope fully to duplicate this mental process artificially [instant associations in the mind], but he certainly ought to be able to learn from it. . . . Selection by association, rather than by indexing, may yet be mechanized. One cannot hope thus to equal the speed and flexibility with which the mind follows an associative trail, but it should be possible to beat the mind decisively in regard to the permanence and clarity of the items resurrected from storage. (p. 106)

Hypermedia tools give permanence to the associations perceived and built in by the creator of the product; hypermedia tools give the ability to place the associations perceived and added by the user of the product. The combination of these options provide the power to achieve Bush's vision of information organization and utility.

Learning Styles

The recognition that learners have a variety of ways to approach the learning task and that experts exhibit traits not shown by novices is no surprise to educators. Joyce (1988) states that:

> Hypertext tools offer the promise of adapting themselves to fundamental cognitive skills which experts routinely, subtly, and self-consciously apply in accomplishing intellectual tasks. . . . Hyper tools promise to unlock these skills for novice learners and to empower and enfranchise their learning. (p. 10)

There is little doubt that "learning is a very personalized activity whose outcomes can be guided by the instruction, but is determined ultimately by the learners themselves" (Grabowski & Curtis, 1991, p. 3). Hypermedia offers considerable power to the learner to determine the nature and extent of their interaction with the given information.

Some caution in the approach to hypermedia use in education settings is needed. Lanza & Roselli (1991) conducted an experiment that compared student learning with a hypertext system versus a very structured form of presentation. "Experimental group responses suggest that hypertext is not for everyone; the hypertextual approach for instructional purposes may be better suited to students with greater ability" (p. 202). In this study, the group of students using the hypermedia based instruction did not show significant differences from the control group using other methods. However, "the scores of the control group are concentrated in the middle of the full range, while in the hypertext group there is a great variability in performance" (p. 202). Lanza and Roselli suggest that the amount of freedom given to students in a hypermedia environment may "be more effectively used by more motivated and mature students who are skilled in controlling their own learning processes" (p. 202). Student differences once again make the task of absolute conclusions impossible.

Conklin's article of 1987, contributes "one must work in current hypertext environments for awhile for the collection of features to coalesce into a useful tool" (p. 17). Hammond (1991) concurs and adds "hypermedia of itself is a poor vehicle for many learning situations. Basic hypertext needs to be supplemented by a variety of tools, tailorable to specific learning situations by the course developer, by the instructor or even by the learner" (p. 120). As Ramsland (1992) suggests "learning is not just content, but involves skills in making the material meaningful and applicable to your concerns" (p. 26). Having the potential is no guarantee that the desired outcome will be reached.

To help provide hypermedia environments that maximize their value in learning, a number of guidelines have been offered. Hartman and Schell (1991) outline four separate points that can be enhanced by the use of hypermedia in learning situations. These include (1) multiple views that encourage learning transfer, (2) an emphasis on application, thereby making the material appear to be more relevant, (3) increased interaction with the electronic text, and (4) simplified evaluation techniques. These concepts are vital to effective learning.

Teachers make an effort to guide the learning process and provide assistance they feel will help. However, Schoenfeld "describes a student who took a teacher's instructions for an assignment as a recipe for completing the task, rather than a way of learning the material" (1988, p. 151). In a hypermedia environment where students must make decisions about the order in which they encounter the material, their approach to any task is forced beyond merely following directions. Students must remain actively involved in making the assignment and the material gain personal meaning for them.

But learning styles are complex and so is hypertext. "If the connections between documents are idiosyncratic and thus intuitively clear to one individual, then those same connections may be unclear to another person" (Rada, 1991, p. 673).

> Some individuals learn well using paper and pencil or from viewing linear movies or other narratives yet, other individuals learn much better from more sensory media. . . . Research suggests that multiplicity of sensory media available can be used significantly for critical educational effect. (Hooper, 1990, p. 14)

No one tool can please everyone. "Hypertext is intended to appeal to one's intuition—to be simple to create and to access" (Rada, 1991, p. 676). But many students work outside this approach. "Not all children learn in a logical progression . . . rather picking up some isolated fact to add to an unrelated collection of knowledge. Only later do they begin to see relationships among those facts" (Bradsher, 1990, p. 314). This comment results from observations in traditional settings. Hypermedia situations could potentially increase this problem.

Grabowski and Curtis (1991) discuss some concerns of using hypermedia systems for learning new concepts. They praise the potential information base that can easily be included into the system.

> Hypermedia systems respond well to what you want to know but largely ignore how, why, and in what form you need to know it, what you know (or don't know) already, what you anticipate finding, how it will help you, or what your problem looks like. (p. 6)

In the traditional library research projects, students success is "largely based on the accessibility of the information, their motivation to access that information, and the ability of the individual to learn in an ambiguous, information rich environment" (p. 6). Grawbowski and Curtis describe hypermedia as a *self contained version* of library research learning. The user is in control of the task and "all of the information contained in the program becomes potentially equal in accessibility, importance, and quality" (p. 7). For some learners this presents an overwhelming challenge.

Grawbowski and Curtis (1991) look at some of the cognitive issues in learning from hypermedia based situations. They identify a number of traits as being influential in the learner's ability to effectively make use of hypermedia tools. These traits include scanning the material with a broad or narrow approach, conceptual integration skills which utilize the value of multiple perspectives, tolerance of risk in the learning situation, and the flexibility to focus on relevant material while filtering out the distractions. They suggest an immediate need for research that connects learning style profiles to learning achievement in hypermedia settings.

While Grabowski and Curtis are strongly supportive of the potential of hypermedia, they do suggest some caution. Teachers that use the library research approach in their classrooms realize the difficulty of determining what outcomes have been achieved. Hypermedia presents a similar debate. "This is not intended to imply that learning does not or will not occur; it simply illustrates that we do not yet know how, for whom and under what conditions it will or will not occur" (Grabowski & Curtis, p. 10).

Learning is a complex task. Dealing with information is difficult for all learners. Hypermedia is a unique tool but "no one arrangement of information proves convenient for all who need that information" (Landow, 1992, p. 18). Landow continues by saying "although both linear and hierarchical arrangements provide information in some sort of order, that order does not always match the needs of individual users of that information" (p. 18). Hypermedia provides more flexibility than many other forms of presentations suggesting the possibility of satisfying a wide range of learners. However, research on the most basic issues of hypermedia is still needed.

HyperCard—the Educators Tool

HyperCard a powerful tool created by Bill Atkinson, provides an environment for creating hypermedia applications. "If you ask Bill Atkinson what he was trying to accomplish in creating *HyperCard* he will tell you that one of his chief purposes was to teach, and that another was to engage people though the aesthetics of the program" (Walker, 1990, p. 334). With the five objects—stacks, cards, backgrounds, buttons, and fields—as a basis, and the ability to link the material at will, educators have been given a potentially effective tool.

HyperCard provides teachers and students with some novel ways to interact with information. "*HyperCard* with a computer is simply a very useful kit of tools for one key aspect of teaching and learning . . . *processing information*" (Campbell & Hanlon, 1990, p. 260). Associations in information is made concrete as "*HyperCard* allows multi-dimensional frameworks to help organize information and present a lay-out that is easily grasped though not readily visible" (Semper, 1990, p. 56). "*HyperCard* mirrors some of the successful strategies for learning, and it therefore becomes a useful tool for thinking and developing reason" (p. 54). *HyperCard* provides the opportunity to create presentations teaching complex concepts, presentations involving multiple sensory channels, and presentations accommodating multiple perspectives on the same idea.

Students appear to accept *HyperCard* as a convenient means to an end. "*HyperCard* allows students to 'create their own knowledge' rather than being limited to someone else's presentations. Our classrooms [Apple Classrooms of Tomorrow—ACOT] were becoming more and more centered on learning instead of on teaching" (Hofmeister, 1990, p. 216). "The ACOT team feels that *HyperCard* is the tool that not only changes the way students use the classroom computer but also dramatically changes how students learn" (p. 229). As explained by Hofmeister, having students create mathematics stacks to teach a process slowed the thinking and forced each person to attend to every step required to complete the process. Students gained by obtaining a deeper understanding of the concepts they were asked to share in their stacks. "With *HyperCard* students are more likely to construct in their own minds a rich and complex representation of the subject at hand" (Lengel & Collins, 1990, p. 193).

Students accept this tool easily and "we [adults] must laugh at ourselves as they take for granted those things that we consider amazing" (Hooper, 1990, p. 25). "While *HyperCard* cannot guarantee that every student has the ability to wrestle directly with knowledge in its original form, it can come closer to that ideal than has been possible with the media that teachers have used in the past" (Lengel & Collins, 1990, p. 191).

Programming in *HyperCard* provides a challenge similar to other programming languages, but "with HyperTalk, the class was able to reach the same programming level in half the time" (Hofmeister, 1990, p. 214). "Students who know *HyperCard* find themselves able to do things that only serious hackers would have attempted previously" (Hofmeister, p. 214). Stanley (1992) defines HyperTalk as "*a language especially designed for people who believe that they are not programmers*" (p. 5). He suggests for students and teachers alike that "knowing how programs work helps you understand your computer better, and makes you a better judge of the software you buy" (Stanley, 1992, p. 4).

Many teachers find *HyperCard* a tool that suggests new ways to present concepts to their students. Unlike having to structure teaching around software designed by someone else, "*HyperCard* was suggesting customized, unique applications for teachers who were non

programmers. These applications matched what the teacher was doing, rather than vice versa" (Hofmeister, 1990, p. 216). Producing the products visualized was often difficult for the teachers. After observing teachers learning *HyperCard*, Walker (1990) comments "it is clear that the average user was having considerably more difficulty mastering *HyperCard* than most early developers had anticipated" (p. 338). Mintz (1990) says:

> *HyperCard* is the most usable, useful tool to come along in my history. Unfortunately for the teacher who really wants to use this 'construction kit' and has little computer programming experience, the sheer size of *HyperCard*, the number of books, manuals, and Help stacks, and the potential are simply too large, too complex, and too overwhelming to be effective. This, at least, is my experience. (p. 157)

Time and effort on the part of the teacher makes:

> *HyperCard* a superb presentation and reporting tool. . . . *HyperCard* allows educators to 'computerize' types of information that have never before been taught with computers. . . . In the hands of a creative artist *HyperCard* can produce a new class of tools for learning. (Lengel & Collins, 1990, p. 191)

Considering the requirements of educational institutions "*HyperCard* is a tool that is absolutely fantastic for education, be it the education of small children or adults, including adults who work in corporations" (Hooper, 1990, p. 8). Semper (1990) states "*HyperCard* is clearly a tool of associative thinking" (p. 56). If one accepts these accolades, one can accept *HyperCard* as an excellent tool for use in education.

HyperCard allows access to all the variations possible in communication mediums—text, sound, graphics, and moving pictures. Peripheral devices can be controlled by including the drivers or special code that allow the *HyperCard* stack to communicate with these devices. As Mintz (1990) says "*HyperCard* is an incredible tool in the hands of users who are willing to understand and use it and an awe-inspiring tool for teachers who have the time, willingness, and ability to use it with and for children" (p. 158). In the report by Hofmeister on the evolution of their ACOT classrooms, he shares the experiences of one teacher. "She couldn't manage the technology very well but could still integrate it into her work" (1990, p. 210). *HyperCard* empowers—teachers and students!

Technology to be useful needs to be used. Hofmeister's experience "showed us that an innovative teacher, *who knew nothing about programming*, could integrate the computer into all academic disciplines" (1990, p. 203). But, perhaps the teachers in this situation are unusual. Koetke (1990) remarks "any technology that we hope to use to improve learning must be adopted and used by classroom teachers. If they don't accept it, it really doesn't have a chance" (p. 351). Having the tool and using the tool still tend to be two separate issues in education.

Tentative Answers to Research Questions

The preceding discussion has presented a number of issues that provide information about hypermedia. While hypermedia provides many positive possibilities in education, there are many unanswered concerns. The flexibility of the hypermedia environment has tremendous appeal to educators despite the expense and complexity of the technology. The evaluation of hypermedia learning tools from the student perspective was not directly addressed. However, from the information presented tentative answers to the research questions can now be considered.

1. What are the students' perceptions of their learning within the hypermedia environment provided by using ACCESS/*HyperCard* in the United States Culture program?

- What are some of the more difficult aspects of hypermedia as perceived by students?

One can expect students to have difficulty using hypermedia as a learning tool. Very large amounts of material can be made available to students, and organizing the presentation of the information is not easy. The cognitive demands of hypermedia require concentration navigate and maintain orientation while assimilating the content. "Sometimes it is unnatural to break your thoughts into discrete units" (Begeman & Conklin, 1988, p. 260) and yet the information will be met in card-sized chunks. In addition, "unless each author writes clearly

and completely, while you might understand the individual nodes, it's hard to follow the thread of thoughts as it winds through several dozen nodes" (p. 260).

- What are some of the factors that students perceive as an advantage if the information is given in hypermedia format instead of print information?

The advantages of hypermedia include a number of items. Sound, images, text, and motion pictures can all be included with relative ease. This integration of media provides both a rich information base and an entertaining environment. The novelty of interacting with multiple media and receiving multiple versions of any information gives the hypermedia document the ability to satisfy a variety of learners. The ease and natural interaction with associations and the removal of the demands of linear writing ease some of the more difficult problems of traditional writing. Electronic access to information provides multiple copies so many students can use the resource at the same time. The computer has the ability to complete information searches quickly and efficiently. Resources that are convenient to use and easily accessible are valuable learning tools.

- What methods do students perceive as effective in determining that they have completed the task of learning the material in a hypermedia format?

Deciding when one has completed reading a book is simple. When all the pages are read, the book is finished. The assignment involved may still be incomplete, but at least one is aware that all the material has been encountered. In a hypermedia format, the nonlinear nature of the presentation makes this conclusion difficult. But reading the complete book does not mean the student has completed the learning. The literature suggests that students will change their thinking to focus more on understanding concepts and less on counting the pages. Using the teachers' suggestions, students can develop a way to recognize the completion of an assignment by realizing the needed understanding of the concepts has been reached. Each person may decide that a hypermedia document has been completely finished for reasons totally different from someone else's reason.

- What do students perceive as advantages to producing their own work as an ACCESS/*HyperCard* stack rather than as a traditional print product?

The comparison of student preference for either hypermedia authoring or traditional writing assignments is difficult. The literature suggests that students will enjoy the opportunity to move beyond the limits of printed material to work in the rich environment of hypermedia. "*HyperCard* provides the possibility of truly multimodal presentation. It can control and present sounds, images, text, and graphics in a dynamic or static manner under user control" (Semper, 1990, p. 53) This tool is flexible enough to "be a full-fledged partner in learning, where learning abilities and styles are clearly multimodal in nature" (p. 53). The computer empowers students with new skills. For example, if a student is not artistically proficient, scanned digital pictures provide quality graphics in assignments. Instead of using drawing skills, the student can produce graphics using technology skills. Each student can achieve the goals of the assignment at a level not easily available in written work where so much depends on writing skill alone.

- What do students perceive as needed personal skills and technical equipment to function productively and efficiently in the hypermedia environment?

The literature review did not provide insight into what personal skills and technical equipment would be needed to provide what students perceive as an acceptable hypermedia environment. The discussion of the four examples of hypermedia products indicated that hypermedia tools are available on a wide level of sophistication. A number of technical skills are needed to fully utilize the power of hypermedia products. Many technical skills were common to each situation but the particular intent of the task will determine specific requirements. The question will be resolved from the research proposed.

2. What do students acquire in the hypermedia environment in terms of recognizing the relationships and associations inherent in the material presented?

The issue of relationships and associations inherent in hypermedia presentations is still that—an issue. "*Concept mapping*, which is a way to help students and educators see the meaning of learning materials...and penetrate the structure" (Novak & Gowin, 1984, p. 1) provides a visual form of student concepts. The links in the material which in print format can

only be implied are made explicit by the electronic links placed in the hypermedia format. If the belief that hypermedia can increase the students' ability to make the associations and connections in the material is correct, then students should be able to produce concept maps of increasing complexity and depth.

Summary

The previous discussion has considered the research questions from the insights provided in the literature review. Tentative answers have been formulated based on the content of the review. However, these answers are merely speculation. The conclusions that appear logical from a theoretical perspective may not be true in an actual application of hypermedia learning tools. The literature consulted showed that researchers seldom asked the students for opinions. Instead, the literature viewed the use of hypermedia from a teacher and researcher point of view. This study took the research questions directly to the students enrolled in the USC course of studies. The information presented in chapter four is obtained directly from the students. The completed study provides specific and detailed answers to the research questions.

CHAPTER III

METHODOLOGY

Information Collection Design for the Research

This qualitative research was conducted in the context of the United States Culture (USC) program of study offered in a large, urban high school. The researcher functioned as an assistant in the technology component of the program. Staff acceptance of the researcher in this role was achieved during the preceding school year. In participant research, "*The ideal is to negotiate and adopt that degree of participation that will yield the most meaningful data about the program given the characteristics of the participants, the nature of staff-participant interactions, and the sociopolitical context of the program* [italics in original]" (Patton, 1990, p. 209). The researcher's role provided maximum access to the perspectives of the people involved in the USC program.

As a participant in the program, the researcher gained an effective position for viewing the events under study. "The purpose of such participation is to develop an insider's view of what is happening. This means that the evaluator not only sees what is happening but feels what it is like to be a part of the setting or program" (Patton, 1990, p. 207). Having learned a great deal about the program during the previous year, the researcher was already aware of the steps necessary to maintain this desired role. Students and staff found the researcher's presence comfortable and helpful because she was a willing and competent assistant in the computer lab.

The researcher began the relationship with students by explaining the purpose of the research and the intended use of the data obtained. Emphasis was placed on the researcher's

ability to make positive contributions to the program. Patton concurs with this approach and suggests "program participants, over time, will tend to judge evaluators first and foremost as people, not as evaluators" (Patton, 1990, p. 212). The researcher, after explaining the research process, was careful to play her role of technical assistant first and be researcher second. Students, after recognizing that the research efforts were not intrusive to the learning, exhibited little concern.

Suggestions made by Patton were followed. This included obtaining information from a number of sources. Rather than relying on a single means of attaining information, the researcher used the multiple sources of information available. Students were consulted; teachers were consulted; personal observations were recorded; student documents were examined; formal questionnaires were used. "By using a combination of observations, interviewing, and document analysis, the fieldworker is able to use different data sources to validate and cross-check findings" (p. 244).

The researcher observed classes conducted in a variety of settings and involving a wide range of activities. All students and teachers completed questionnaires. Interviews with all teachers and a small sample of students provided detailed personal perspectives. Informal discussions with group members provided first hand information. Assignments completed during the research period gave concrete evidence of the progress individual students made in relation to the mastery of the material presented. The combination of these tools provided a rich amount of data from which to make an analysis and formulate answers to the research questions.

Overview of Research Instruments

Observations

Observations of activities was ongoing during the research period. "The purpose of observational data is to *describe* the setting that was observed, the activities that took place in that setting, the people who participated in those activities, and the meanings of what was observed from the perspective of those observed" (Patton, 1990, p. 202). Formal observations were aided by a checklist and notes taken during each session. For informal observations, notes were made each day immediately after leaving the research setting. During all observations the researcher made a concentrated effort to maintain a focus on the research questions.

Observations were conducted in a variety of settings. Patton (1990) outlines a number of advantages to be found in observing from the position of the active participant. He includes such things as: (1) from the inside one is better able to gain an understanding of the context of the program, (2) the firsthand experience allows for greater openness and a discovery oriented approach, (3) the researcher has the opportunity to see things that may be routinely missed by the other participants, (4) the researcher may become aware of factors that participants would not willing share during interviews, (5) the researcher can move beyond the selective perceptions of others, and (6) the researcher can access personal knowledge and direct experience as resources to aid in the understanding and interpretation of the events being observed.

In this study, the researcher was able to use her twenty years of teaching experience and previous personal involvement with the USC curriculum and organization to provide guidance and focus during the observation sessions.

Questionnaires

Questionnaires were designed by the researcher to meet the needs of this particular study. Feedback on the initial products was provided by teachers, several graduate students, and members of the dissertation committee. Reliability of the instruments was achieved by pilot testing the forms with the entire group of students taking the course last year and revising them based on the feedback received from the process. This process was recommended by Brinkerhoff, Brethower, Hluchyj, and Nowakowski (1983). A final revision was made to produce the forms used for the present study.

The basic questionnaire used with the teachers was piloted with the teaching staff in the previous year. Adjustments to the questionnaire were made to accommodate the changes made in the design of the program and to better meet the needs of the present research. Teacher questionnaires sought general background information about teaching experience and training. In addition, the USC teaching team was asked to share their perception of the program's objectives and intent. They were asked to explain their understanding of what hypermedia was and to outline the perceived value of hypermedia to their course of studies. Personal concerns, successes, and opinions were solicited through a variety of questions. In addition, the information gathered provided direction for the interviews and suggestions to be included in the observation checklist.

Informal Interactions

The informal interaction between researcher, teachers, and students was a key component in the study. Patton uses the term informal conversational interview for this activity. The approach:

> Relies entirely on the spontaneous generation of questions in the natural flow of an interaction, typically an interview that occurs as part of ongoing participant

> observation fieldwork. During an informal conversational interview, the persons being talked with may not even realize they are being interviewed (1990, p. 280).

This non-intrusive but constant interaction provided the opportunity for the researcher to verify and double check information being obtained from all the tools being used. Students were inclined to openly share their feelings and observations once this informal interaction became accepted as a natural part of their day.

The informal interactions also provided the opportunity Patton points out for determining what things did *not* happen that one would expect to happen. For example, one might assume the amount of time involved in the computer lab component would greatly increase the students' ability to keyboard. Research conducted during the formal evaluation of the program indicated this is not true. The researcher learned from students that very little improvement was made. Instead of working on genuine keyboarding skills, students settled for developing coping skills. (Smith, 1992a). By maintaining an open and flexible approach during all interactions the researcher did not reach a conclusion that was not supported. This situation serves as a reminder that "plans made during design should be revised as appropriate when important new possibilities and source of data become available" (Patton, 1990, p. 233). Flexibility was a key factor in the present research project.

Interview Sessions

General interviews were conducted with all three members of the USC teaching staff. This involved "outlining a set of issues that are to be explored with each respondent before interviewing began" (Patton, 1990, p. 280). These protocols, developed from an analysis of questionnaires administered during the first weeks of the research, and the researcher's field notes, provided a necessary focus to make the best use of the time available for this activity. The opportunity for each teacher to speak when they had the total attention of the researcher and adequate time to answer questions produced some key information. The protocols served

as a guide while leaving the researcher and interviewee the freedom to pursue any interesting topic that arose.

Interviews were conducted with a select group of students. A set of interview protocols had been developed for this purpose and tested the previous year. This experience suggested that the researcher gained the most valuable information from students by providing general guidelines and then encouraging the students to express their own concerns and feelings about their experiences. These interviews gave the researcher the opportunity to gain an in-depth view of individual perspectives.

A tape recorder was used during these in-depth interviews with students. "In addition to increasing the accuracy of data collection, the use of a tape recorder permits the interviewer to be more attentive to the interviewee" (Patton, 1990, p. 348). In addition, the researcher used a method of note taking. As Patton suggested, the notes taken were helpful in formulating new questions during the interviewing process. The interview protocols were used to maintain the overall direction while the notes served to add specific detail to the information. Rather than interrupt the flow of conversation, the researcher made a note of the relevant point. When appropriate the researcher went back to the recorded comment and sought further clarification. In addition, the notes helped to remind the researcher of parts of the tape that would of particular interest in providing direct quotations to be used during the data presentation.

After each taping session, following Patton's suggestions, the tape was checked for the quality of sound, notes were expanded and clarified, areas needing verification were noted, and brief observations about the session itself were made. These activities were "a time of quality control to guarantee that the data obtained would be useful, reliable, and valid" (Patton, 1990, p. 353). Interacting with the information immediately following each interview provided the researcher with continued guidance for verifying and collecting data.

As mentioned by Patton, interviews have certain disadvantages. Interviews report only that one person's perspective and reflect such limitations as faulty or selective recall, personal bias, and emotions both during the time of interview and the event. Although the time required

to complete the interview process was lengthy, the tool did allow the researcher to "go beyond the external behavior to explore the internal states of persons who had been observed" (Patton, 1990, p. 245). As a supplementary tool, the interviews provided a valuable method of verifying the information obtained in other settings.

Documents and Student Products

Documents that exist in connection with the program were carefully examined by the researcher. The process of examining documents served a "dual purpose: (1) they are a basic source of information about program decisions and background, or activities and processes, and (2) they can give the evaluator ideas about important questions to pursue through more direct observations and interviewing" (Patton, 1990, p. 233). The documents provided key information to the evolution of the USC program. In particular, the documents explaining the hypermedia products from Brown University were particularly informative in learning the details of the hypermedia tools being used by the students.

Products submitted by the students also gave the researcher a view of their progress with the topics covered in the program. The researcher focused primarily on the electronic products produced, but a number of traditional written assignments were also collected. The assignments were assessed to provide evidence of the associations and connections students were developing within the body of integrated material being presented in this interdisciplinary program. With the assistance of the teachers in the program, the researcher examined the student products for specific evidence that students were learning to view the topics as an integrated whole.

A small group of students was closely monitored to obtain detailed information about the hypermedia environment. This provided the opportunity to understand the program from an individual student perspective as the experience evolved. To help ensure the information received was without bias and was representative of student experiences in the program, this

group was not identified to any person other than the researcher. Some of the specifics of their experiences are included in the report.

The privacy of the information gathered was maintained. Each student was assigned a computer account on the network. The researcher used the computer account numbers to identify each student's work. All such material was removed from the school building and added to the researcher's files. The only person with access to this material was the researcher. Teachers were not given any specific information about the data. To maintain privacy, the names of any individuals that appear in the written report of the study have been changed.

Overview of Data Analysis and Interpretation

The study is designed to produce data from multiple sources to support the production of a rich description of the student's perception of their experience with hypermedia. "Understanding that interviewing and observation are mutually reinforcing qualitative techniques is a bridge to understanding the fundamentally people-oriented nature of qualitative inquiry" (Patton, 1990, p. 32). Finding the means to discover the desired answers in the multitude of information required careful planning.

To proceed with the analysis, the investigator used two primary sources "to draw from in organizing the analysis: (1) the questions that were generated during the conceptual phase of the study and clarified prior to final analysis and (2) analytic insights and interpretations that emerged during data collection" (Patton, 1990, p. 378). Blending of the two sources was necessary to produce a description that fulfilled the researcher's goals.

The analysis began by looking for patterns in the data. Tentatively, the perceived patterns were used to establish categories or themes that would be used in sorting the data. Data was examined by looking at the similarities in the material placed in a single category. Patton uses the term internal homogeneity to classify the extent to which the pieces placed in a category are contextually connected. In addition, the differences between categories were

examined to ensure that the categories were distinct and the data was correctly placed. Patton's term external heterogeneity is used in conjunction with this concept. The differences among categories needs to be clearly discernible so that the data can be placed correctly.

Following techniques described by Strauss and Corbin (1990), the data analysis produced several categories. Keeping in mind the need to have the categories contain the data without forcing the data into a particular form required numerous checks as the data was separated. A cut and sort approach allowed the researcher to redistribute the material until a clear picture emerged from the data. During the sorting and categorization of data, the literature and research questions were reread to ensure the focus of the study was maintained.

Interviews

The qualitative data obtained from interviews and informal discussions formed the basis of the ethnographic picture required to complete the study. The notes obtained from the process were sorted to identify major themes and concerns. The researcher looked for a variety of specific examples to support the presentation of the material. Unusual or unexpected comments that arose during this process underwent further clarification by checking the data with other members of the group on an informal or interview basis.

The interview material was dealt with by using what Patton terms cross-case analysis. "Cross-case analysis means grouping together answers from different people to common questions or analyzing different perspective on central issues" (Strauss & Corbin, 1990, p. 376). The content analysis was produced by "identifying, coding, and categorizing the primary patterns in the data . . . from interviews and observations" (p. 381). This process resulted in a picture of the students' perceptions of the learning experience.

Questionnaires

Questionnaires included a variety of formats such as open-ended questions, Likert-scale response forms, and simple checklist questions. Analysis of the data included using the SPSS statistics program on the VAX to obtain frequency of responses and identify patterns in the responses. A cross tabulation procedure was used to calculate the relationships between two variables at a time. For example, it was possible to check to see if the amount of computer experience was contributing to a positive attitude towards the use of the hypermedia corpus as a teaching resource. The SPSS program provided a convenient tool to explore these types of questions.

The quantitative data was used in conjunction with the qualitative material to provide a rich description of context supported with numerical facts. Open ended questions were analyzed for content, frequency of similarity in responses, clarity of explanation, strength of argument in the answer, and connection with comments arising from the interview material. The analysis of material by the researcher was checked by having the teachers of the USC program read and verify the interpretation placed on the data.

Observations

Classroom observations were conducted on an informal basis. With the researcher serving as a key participant in the program, the disruption was minimal. Students readily accepted the researcher as a natural part of their environment. The recording of observations included only actual events viewed by the researcher. The context and description of the classroom became a composite of the observations made over the entire research period. Specific examples and details included in chapter four of this dissertation allow the reader to share a perspective of the program similar to the perspective developed by the researcher.

Student Products

Students produced a wide variety of assignments and were involved in a number of different activities in the USC program. Examining the products produced by the students allowed the researcher to observe the outcomes of these experiences. Understanding what each activity involved and knowing what was intended from a teaching perspective, helped the researcher to focus on relevant components of the students' efforts. For example, the *HyperCard* stacks authored by the students included components such as a map card. The map cards provided a visual representation of the student's mental concepts and showed the connections understood in the material studied. The artifacts described provide a rich description of student development within the context of the hypermedia environment.

Validity and Reliability

The questions of validity and reliability in qualitative research is complex. Patton suggests that "the validity and reliability of qualitative data depend to a great extent on the methodological skill, sensitivity, and integrity of the researcher" (Patton, 1990, p. 11). In a qualitative study, the researcher must work to ensure that the focus is maintained at all times on relevant issues. By carefully formulating the research questions, the researcher provides a framework that maximizes the use of the professional skills and knowledge the researcher brings to the situation.

Strauss and Corbin use the term theoretical sensitivity to refer to the personal qualities of the researcher. "Theoretical sensitivity refers to the attribute of having insight, the ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't" (Strauss & Corbin, 1990, p. 42). The detailed literature review and analysis included in chapter two of this dissertation is evidence that the researcher has theoretical sensitivity. Strauss and Corbin go on to include professional experience as a source of

researcher sensitivity. The researcher's background provides an excellent basis for the needed skills. The last area included in Strauss and Corbin's list is personal experience. The researcher is focused on a topic that has arisen directly from personal experience.

The research process made constant use of the expertise of the instructors in the program. To provide a control on the interpretations of the data by the researcher, discussions with the three teachers were ongoing. The researcher openly discussed personal preferences and biases with the teaching staff. The group interaction provided a way to control these factors. Whenever possible, a consensus of opinion was established by the group based on the gathered data. When immediate consensus wasn't forthcoming, verification was sought by rechecking the information source. Examples from the data are included in chapter four of the dissertation to provide clarity in the description and explanation for the reader.

The qualitative data used to produce the description originated from a variety of sources over a considerable period of time. As the term progressed, the students benefited from their continued experience in the program. The researcher has attempted to obtain an understanding of this progression to present to the reader. To supplement immediate data, students were asked to share reflections about their past experiences in interviews, questionnaires, and informal discussion.

The qualitative nature of the report required a description of the context of the data and the reasons for the interpretation placed on the data. Because of the many sources of data, cross checking of the key issues was possible. In addition, where applicable, the material was critiqued by colleagues familiar with the setting or the research design but not directly involved in the research. Having multiple perspectives available helped ensure that comments reflected the reality of the program and not just the researcher's opinion. Teachers provided guidance during the analysis and interpretation of the data emerging from the research process.

Reliability of the research is enhanced by working closely with all participants, involving all group members, and maintaining an awareness of the research goal at all times. The description includes only what was observed to happen or was reported by the research

instruments. The use of multiple sources allowed information to be cross-checked for clarity and since the research activities were incorporated into the daily expectations of the program wherever possible, the intrusion into the program was minimized. For this program at this time, the report on students' perceptions of learning in a hypermedia environment reflect the reality of the program under investigation.

CHAPTER IV

DATA PRESENTATION

The research study has been executed as described in the research design chapter. Data collection began on September 10 when school started for the year. The process of data collection continued on a daily basis up to and including January 25, 1993 when the final questionnaires were completed by the students in the research group. The research schedule was adjusted from the initial plan of chapter three of the dissertation to accommodate the classroom instruction needs of the program.

Data Collection Process

Data collection involved using a wide variety of tools during the research period. Classroom observations were made and recorded. Questionnaires were completed by the student participants in October and January. Informal discussion with students was ongoing. Formal interviews with two students were conducted in January. A large collection of student products was gathered. Throughout the research schedule, teachers provided informal and formal feedback on student comments and progress. Clarification of data was done on an ongoing basis throughout the research time period.

This chapter of the dissertation has been organized into two sections. The first section of the chapter shares details which describe the technical background and skills of the research subjects and provides further description of the technology setting in which the hypermedia tools are used. The second section presents the data pertaining directly to the assessment of student perceptions of their learning experience with hypermedia tools.

Information about the research site and the background of the student participants is given to help the reader understand the hypermedia learning environment being studied. This description includes details about the computer experience level of the participants, the Macintosh lab, the computer activities included in the course, learning styles, browsing stacks, and authoring stacks.

The student perception categories are presented. Six categories were identified and each will be presented individually. Specific data will be shared to support each category. The six categories used are:

1. the hypermedia environment provides a high level of motivation to learn
2. hypermedia documents create navigation concerns
3. producing hypermedia documents becomes a very personal process
4. authoring and browsing skills have a strong interrelationship
5. hypermedia fosters multiple perspectives on the topics investigated
6. hypermedia learning promotes an increased competence with technology.

The evidence presented by the collected data indicates these issues are involved in the formation of students' perception of learning in a hypermedia environment. This evidence is used to provide answers to the research questions posed at the end of chapter one of the dissertation.

After the data had been collected, the researcher organized the data into the two broad categories mentioned above. From there, the data was sorted into smaller categories within each group according to content. To identify categories and subcategories, the data was broken into small pieces where each piece could be labeled. These labels provided the key features that were used to define each category that has been used. Examples of these labels would include complaints, technical problems, and sharing expertise. After identifying the features in detail, categories were redefined until each piece of data could be suitably placed.

Final definition of the categories in each of the two main groupings were made. The data was re-examined to determine the connections between categories and subcategories. Each piece of data was placed into a suitable context within the categories. To do this, the researcher had to determine precisely what elements would be included to adequately describe

each category. The particular conditions within the action being studied were instrumental to completing this process. After this synthesis of the data was completed, each phase was checked and rechecked against the data.

The researcher went back to the participants to obtain verification of the sorting process. The three teachers of the USC course of studies provided verbal feedback. In addition, individual students were asked to clarify certain points obtained from questionnaires and observations. Documents, student products, and technical equipment were perused one more time. Each category was again checked to make sure the category was correctly defined and the data had been placed correctly. For both groupings, a description is provided and supporting data is presented.

Background—Research Site And Student Participants

The group of students involved in this research project are members of the United States Culture (USC) course of studies. At the beginning of the study the enrollment in the program was 55. This number had dropped to 48 by the end of the research period. Students who select the USC course of studies intend to continue their formal education after completing high school. The section of the USC program studied includes a computer component and is designated as a College Preparation level course. Teachers have the expectation that their students will be attempting to develop a knowledge base and the study skills needed to succeed in college.

Background—Computer Experience Information

In the initial questionnaire completed in October, a number of questions elicited background information about the groups' computer experience. Not all students completed the Computer Experience Tally sheet. Of the 38 students that did respond to these questions,

only 2 (5%) students indicate no previous experience with a word processor while 2 (5%) students indicate they were familiar with all five word processors mentioned. In all, 32 (84%) of the students responding indicate skill with two or more of the word processors listed on the Computer Experience Tally sheet (see Appendix A).

Table 1. Computer Experience Tally—Word Processing

Software Title	Number Finding Application Familiar
MacWrite	4
AppleWorks	32
Microsoft Works	21
Microsoft Word	17
WordPerfect	30

Table 2. Number of Word Processors Familiar to Students

Total Word Processors	Number of Students	Percentage of Students
0	2	5 %
1	4	11 %
2	8	21 %
3	14	37 %
4	8	21 %
5	2	5 %

The group of students in this research project self-reported considerable expertise with computers and rank themselves as being capable computer users. All 49 students completing the questionnaire responded to this question. On a scale of 1-6 ranging from "non-existent" to "excellent," 37 of the 49 (76%) students responding to the question rate themselves in the range of 4-6. When indicating the frequency of computer use prior to the start of the program, student responses on a scale of 1-6 ranging from "never" to "every day," 22 of the 41 (54%) responses are in the 1-3 range.

Table 3. Student Self-Rating of Computer Competency

Scale 1-6:	Number of Students	Percentage of Total
1 Non-existent	0	0 %
2	4	8 %
3	8	16 %
4	16	33 %
5	16	33 %
6 Excellent	5	10 %

Table 4. Student Self-Rating of Frequency of Use

Scale 1-6:	Number of Students	Percentage of Total
1 Never	1	2
2	10	20
3	13	27
4	12	24
5	7	14
6 Every Day	6	12

Students were also asked to indicate the extent to which they felt their computer skills would increase as a result of being part of the USC program. On a scale of 1-6 that ranges from "not at all" to "greatly," 35 of the 41 (85%) responding to the question are in the range 4-6. In addition, only 4 (10%) students indicate that they do not use the computer for other tasks. The variety of tasks identified by students as jobs being done with a computer include word processing of essays and chemistry lab reports, creating resumes, writing letters, completing drafting assignments, doing layout work for yearbook pages, and using telecommunications programs. These tasks are done on home computers or in the school computer labs outside of the regular class schedules.

Table 5. Rating of Anticipated Computer Skill Increase by USC Students

Scale 1-6:	Number of Students	Percentage of Total
1 Not at all	2	4 %
2	2	4 %
3	4	8 %
4	13	27 %
5	16	33 %
6 Greatly	12	24 %

The students were also asked to state their prior experience with *HyperCard*. Of the 41 responses to this question, only 2 (5%) students indicated any previous experience. Both answers are accompanied by the explanation that since *HyperCard* is available on their home computers, some exploration had been done just for fun. No instruction had been received and no actual use had been made of the computer program.

Students were asked to provide information about computer access at home. Only 11 of the 47 (23%) students responding to the question indicate they do not have a computer in their own home. Five of these 11 students state they can gain immediate access to a computer at their parents' place of work or at a nearby neighbor's home. Three students have both an IBM/compatible and a Macintosh in their own home. Twenty-six of the 47 (55%) students responding have access to an IBM/compatible only.

Table 6. Home Computer Availability to USC Students

Type of Computer Available	Number of Students Stating Choice
IBM/compatible	29
Macintosh	4
Apple	3
Type Unspecified	3

While the amount of computer experience and availability of technology appears high, the actual skill level of this group of students at the beginning of the study was rather weak. Students displayed considerable lack of understanding of how a computer works, the difference between files and applications, how the Macintosh desktop is organized, and how

data is stored and accessed. This problem was evident from the questions asked and the errors made while trying to move between drives, save files, and open files from previous lab sessions.

A problem observed by the researcher with considerable frequency during the first weeks of the study was the confusion caused by having more than one disk icon on the desktop at any given time (see figure 8). Students displayed an inability to move from one disk drive to another without getting lost. During most lab classes, these students had to work with at least three disk icons on the desktop which appear from connecting the workstation computer to the server. The three disk icons which appear at all sessions using ACCESS are the USC## (each student has their own particular number), ACCESS, and HyperCard2.

In addition, the students are asked to save a back-up copy of their work onto a data disk. Once a disk is inserted into the drive, another disk icon appears on the desktop. Students might also require a word processor application. This will either create another icon on the desktop or must be found on the hard drive. During some class periods, another disk icon is needed which provides the storage space for student work that will be collected and sent to Brown University. This creates yet another disk icon on the desktop.

The navigation on the desktop is complex on a second level. A disk icon is opened by either double clicking it or using the menu bar to select open file and moving to the correct icon by switching drives. When the disk icon opens, students see a list of all the files on the disk that can be read by the application in use. On October 2, 1992, the list in the ACCESS disk totaled 37 files. This included the stacks needed to run ACCESS plus a number of stacks intended for browsing. The HyperCard2 disk contained 28 files. This included the art bits and art ideas stacks that students used to obtain many of the graphics used in their own stacks.

Figure 8: Macintosh desktop icons.

Within their USC## drive, files are embedded in another layer. Two folders appear when the disk is first opened. One folder contains only the journal entries and is needed only when moving the journal entries to be collected for mailing to Brown University. The second folder titled student materials contains three more folders. One folder holds the stacks created by the individual, another has the notes that were saved, and the third holds information used by the ACCESS computer program. Most of the students had considerable difficulty moving from a file located on one disk icon to a file found elsewhere.

Another problem observed was in the task of saving a file or document. When the students in the study saved a file, the researcher became aware that these students had little understanding of where the file was being saved. Few students realized how to control where the file was placed. When the work is done in ACCESS, the computer program controls the

placement of the file. Stacks and notes are automatically placed inside the correct folder on the correct disk. However, to save back-up copies of any documents, the user needed to switch the drive to the correct disk before the save process was used.

Saving files created considerable difficulty for most students when working in *Microsoft Word: Version 4*. If the word processor was being used from the server, the file is saved into the system folder unless directed otherwise. If the word processor was opened from the hard drive, the file is saved inside the word processor folder on the hard drive unless directed otherwise. The lab instructor and researcher made frequent checks of system folders and application folders on the workstation computers. These checks found a number of student documents had been saved incorrectly. This fact demonstrates that most students continued to have difficulty getting their documents saved to the correct place.

Students rated themselves as familiar with a number of word processor applications. This self-rating was accurate, and all students could successfully complete a text assignment with a word processor. However, very few students made use of the features of a word processor that would have speeded up their work. For example, students used multiple periods to create a dotted line rather than selecting a tab with a dotted leader. Students indented paragraphs by hitting the space bar. Considerable instruction was required to help students learn to use the ruler for setting margins, creating indented paragraphs, or justifying text. For most students, the word processing activities provided their first use of an electronic spell checker—a major advantage to word processing. These weaknesses in using the features basic to effective word processing contradicted the ratings the students gave themselves.

Many students within this group were encountering their first experience with a Macintosh computer. For most students, previous experience has been in a command line environment and graphical interface using a mouse was new to them. In addition, many students had never worked with a computer in a networked situation. Many students showed considerable trouble distinguishing when an application could be opened from the computer itself versus opening the application from the server. This problem was compounded by the

fact that students often used different computers on different days. Students needed instruction to learn to determine if the machine they were using actually had a hard drive.

The research subjects showed considerable variation in computer skills. In addition, the environment in which they work was quite complex. Regardless of the skill level when entering the program, students were required to master a number of new techniques and to produce work of an acceptable standard. The complexity of the computer environment played a considerable role in the perception each student developed about learning with the hypermedia tools provided to them.

Background—The Macintosh Lab

The research setting included a variety of student groupings and classroom situations. The primary observation setting was the Macintosh lab used by the USC program. This lab included a variety of Macintosh machines connected to either an *Ethernet* or *Appletalk* network. All machines are served by an Macintosh model SE30 using *MacJanet* server software. In September, student computer stations included three Macintosh MacPlus computers with external disk drives, six Macintosh LCIIs with color monitors, 13 Macintosh SEs—four with external hard drives, two Macintosh Classics, and one Macintosh IIsi, for a total of 27 machines. In January, the three MacPlus computers were removed from the network and replaced with two additional SEs. At the end of the research study, 26 student stations were available.

Other equipment was provided for student use. The Macintosh IIsi station included the only scanner available for the group and was used with the *HyperScan* program. The six Macintosh LCIIs and the Macintosh IIsi are capable of direct input of sound and the Audio help stack provided with *HyperCard* was used in this process. The two Apple Laserwriter II printers served every computer on the network. The mobile teacher demonstration station consists of a Macintosh MacPlus using an external hard drive and is equipped with a PC

Viewer. The lab had a mobile station equipped with a VCR, videodisc player, and a monitor. These mobile units are shared with other classes in the school. The seventh Macintosh LCII office station is reserved for teacher use, but can be used by students if needed.

The classes in the Macintosh lab were usually attended by half the total enrollment in the USC program at a time. With a total student enrollment of 55 and some computers sometimes not working, the number of students needing a computer often exceeded the number available. The office machine reserved for teacher use was often utilized as a student workstation. As enrollment dropped, the usual group of 24 students could be accommodated in the lab more easily. With a few students absent on any given day, the lab on most days was able to handle the number of students present.

The demand on the network server with 24 students active at any one time created numerous technical problems for the class. The network has been unable to maintain dependable service for this many workstations. The combination of overload, software conflicts, and faulty hardware components has resulted in many stoppages of the network. As a result of network problems, student work has frequently been lost.

The *Appletalk* network was served with phone-net connectors and phone cable. A number of short pieces of cable rather than a single length were used to run the cable to the far side of the room. Each additional connection increased the number of opportunities for a disconnected wire to interrupt service. The *Ethernet* connectors also contributed problems. The cable used for Ethernet is not very flexible. Connecting the cable into a computer connection often places the cable in an extremely bent position. These connections were often jostled loose as a result of a computer being bumped or a table being moved.

The machines using the *Ethernet* were often unable to maintain their connection to the server. To provide as many working computers as possible, these computers were switched from the *Ethernet* to the *Appletalk* network. This coping strategy allowed the students to continue to work but further slowed the rate of work by adding to the load on the *Appletalk* network. In addition, an *Appletalk* network is slower than the *Ethernet* in moving the data

from a workstation computer to the server and back. The process of getting each student onto the network and into the ACCESS program used a considerable portion of each class period.

Networked computing is a different working environment than that provided by an individual stand alone computer. USC project students had to learn to save their work frequently so that if the network was interrupted, the loss of data was minimized. Students learned to accept that tasks done in a networked situation were done slower than with a stand alone machine. Technical problems can—and did—occur that were beyond the control of either students or teachers. Student perception of the efficiency of technology based learning was undoubtedly influenced by the nature of networked computing.

Background—Student Computer Activities

Activities in the lab were designed to complement the work being done in the regular classroom component of the program. The technical skills students were required to learn were practiced in realistic applications designed to reinforce the knowledge base being gained in the literature and history classes. Constant interaction by the three teachers working with the program helped to maintain the integration of the three components—literature, history, technology—into an interdisciplinary program where students study American culture as a cohesive topic rather than learning three isolated subjects.

An assignment given in early October gave students their first ACCESS authoring experience and provided an illustration of the integration being planned. The assignment required the completion of a five card stack. The stack included an introductory or overview card introducing a concept and establishing the context of the concept in the course. Two strands were then created. Each strand consisted of two cards. On the introductory card two buttons were placed to provide the electronic link to the two strands. An example of a student product is shown on the next two pages (see figures 9 and 10). The graphic shown was not part of the initial assignment but was added by the student after receiving instructions on how to

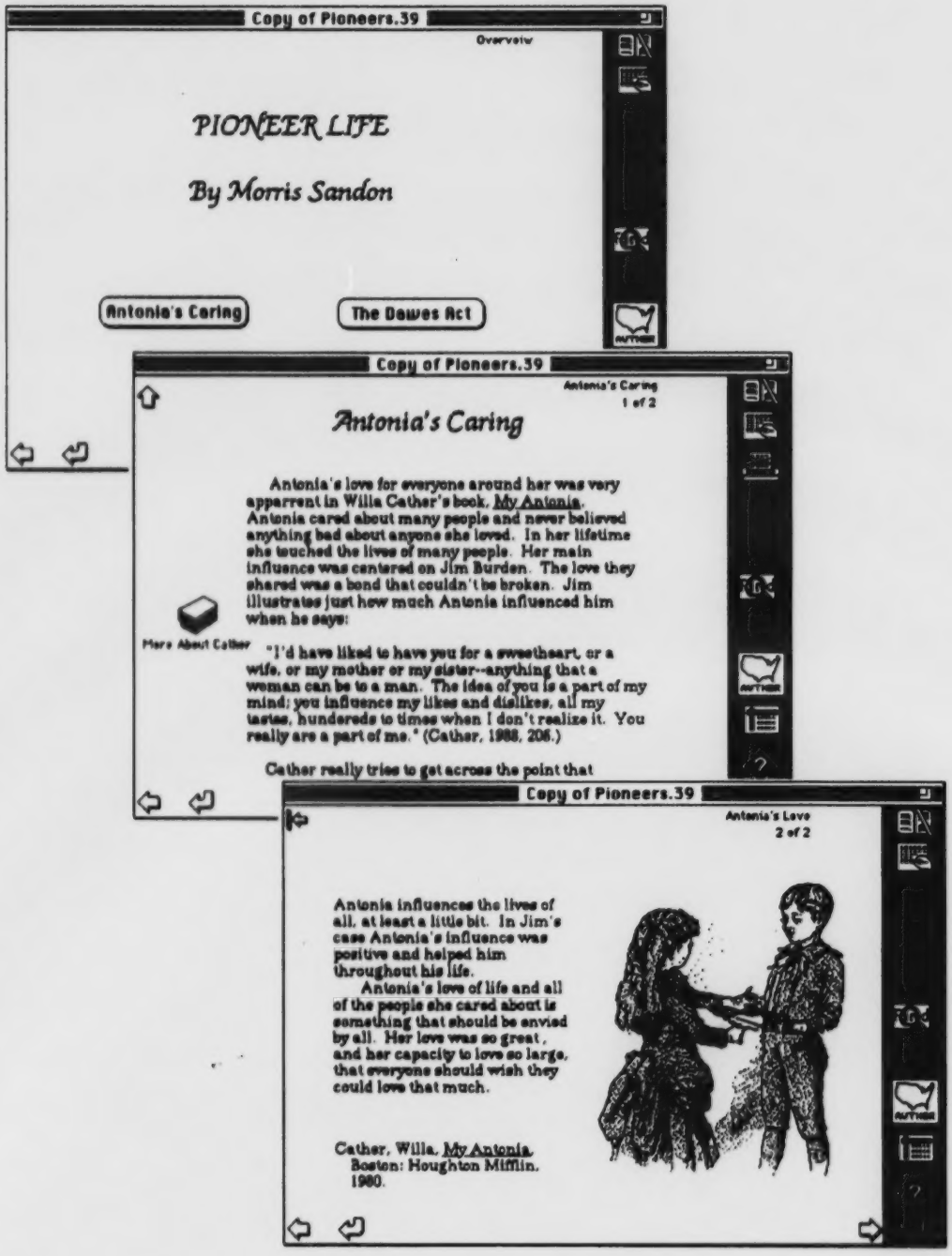
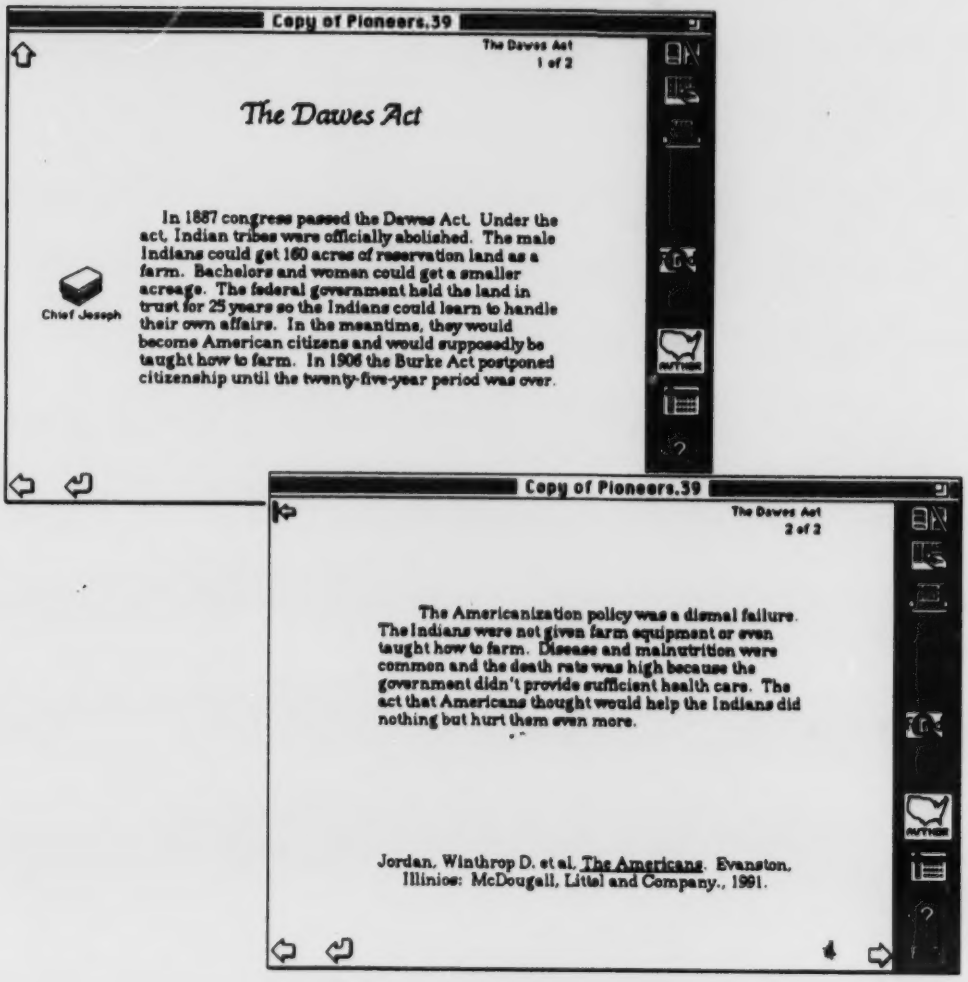

Copy of Pioneers.39
Overview
PIONEER LIFE
By Morris Sandon
Antonia's Caring
The Dawes Act
Copy of Pioneers.39
Antonia's Caring
1 of 2
Antonia's Caring
Antonia's love for everyone around her was very apparrent in Willa Cather's book, My Antonia. Antonia cared about many people and never believed anything bad about anyone she loved. In her lifetime she touched the lives of many people. Her main influence was centered on Jim Burden. The love they shared was a bond that couldn't be broken. Jim illustrates just how much Antonia influenced him when he says:
More About Cather
"I'd have liked to have you for a sweetheart, or a wife, or my mother or my sister--anything that a woman can be to a man. The idea of you is a part of my mind; you influence my likes and dislikes, all my tastes, hundreds to times when I don't realize it. You really are a part of me." (Cather, 1988, 206.)
Cather really tries to get across the point that
Copy of Pioneers.39
Antonia's Love
2 of 2
Antonia influences the lives of all, at least a little bit. In Jim's case Antonia's influence was positive and helped him throughout his life.
Antonia's love of life and all of the people she cared about is something that should be envied by all. Her love was so great, and her capacity to love so large, that everyone should wish they could love that much.
Cather, Willa. My Antonia. Boston: Houghton Mifflin. 1980.

Figure 9: Five card stack example—cards 1-3.

BEST COPY AVAILABLE


Copy of Pioneers.39
The Dawes Act
1 of 2
The Dawes Act
In 1887 congress passed the Dawes Act. Under the act, Indian tribes were officially abolished. The male Indians could get 160 acres of reservation land as a farm. Bachelors and women could get a smaller acreage. The federal government held the land in trust for 25 years so the Indians could learn to handle their own affairs. In the meantime, they would become American citizens and would supposedly be taught how to farm. In 1906 the Burke Act postponed citizenship until the twenty-five-year period was over.
Chief Joseph
Copy of Pioneers.39
The Dawes Act
2 of 2
The Americanization policy was a dismal failure. The Indians were not given farm equipment or even taught how to farm. Disease and malnutrition were common and the death rate was high because the government didn't provide sufficient health care. The act that Americans thought would help the Indians did nothing but hurt them even more.
Jordan, Winthrop D. et al. The Americans. Evanston, Illinios: McDougall, Littel and Company., 1991.
4

Note: The cards are displayed in the order the author created the cards when making the stack. The buttons on the first card allow the user to visit either of the two strands. Since the buttons are placed with the Antonia's Caring strand on the left, most users will visit this strand first despite the fact the order is not a key feature in the presentation. The graphic used on the third card was not placed in the stack in the original version but represents an addition made by the author to enhance the presentation after learning to use the scanner.

Figure 10: Five card stack example—cards 4-5.

BEST COPY AVAILABLE

scan images. The text position was altered slightly to accommodate the placement of the graphic.

The five card stack was intended to share the students' understanding of some concept from the frontier development of the United States. One strand contained information taken directly from the novel My Antonia by Willa Cather. This selection was the current novel being covered in literature. In the second strand, the same concept was discussed from a historical perspective and supported by material covered in the history component. This assignment provided the opportunity for the students to learn some important technology skills, and to connect two perspectives of a selected concept.

The three components of the USC course of studies provide a unique learning environment for students. The assignments are designed to integrate the material being learned into a single entity. In addition, the material is made relevant and applicable to each individual student wherever possible. The three components are intended to work together to meet the goals of the program. The interaction of the instruction, assignments, and expectations in all three settings is organized to maximize the opportunity for the success of each student.

The lab component provides instruction on two levels. New technology skills are taught both formally and informally in this setting. At the same time, information relevant to understanding the culture of the United States is being learned. The hypermedia learning environment provides the opportunity to gain skills in both areas simultaneously. The complexity of the dual purpose served by the hypermedia tools should be reflected in the students' perceptions of the learning environment.

Background—Browsing of Stacks

Students used the ACCESS stacks in much the same way that library books would be consulted. Typically, students were given an assignment sheet that provided some guidance on what portions of the stacks would be most relevant to their studies. Students were encouraged

to use the note taking feature of ACCESS during their browsing activities. Initially, almost half the students in the group were reluctant to use this on-line note taking feature. By the end of the research period, most students would activate this feature without encouragement. Students indicated they valued the ability to work so easily and quickly with the new information and the note taking feature. Above all, they indicated having a set of notes that were easily printed, saved, and read helped them to learn the material being covered.

Students did the browsing assignments on an individual basis, with each person working at their own computer, setting their own pace, and making their own decisions about what to see. However, a considerable amount of informal exchange occurred during the browsing exercises. Students often asked where to find a particular topic or commented on how interesting a particular strand was. These comments were not usually directed to any specific person but were in the form of a general comment added to the group interactions. Sometimes there were responses; sometimes not. Students not yet as far along as students making comments used the feedback to guide their own efforts. When one student found a particular piece of information was incorrect or a button did not function correctly, the information was shared spontaneously so that others became aware of the problem.

Browsing assignments were designed to aid the students' efforts to learn the material. Frequently, the notes taken by students while browsing were printed and submitted for grading. For some assignments, students were required to provide answers to specific questions designed to guide the interaction with the information. During other browsing activities, students needed to formulate explanations, comparisons, contrasts, and connections within the information in the stacks (see Appendix B).

For all students, using an electronic document as resource material was a novel experience which began with their introduction to the USC program. Many students commented that while they never read books from the library, reading the information in the stacks was interesting. Many students felt that having the material available in such a convenient format and having the time in class to do the work meant the information was

actually read. These students confessed to seldom using the library and seldom doing the reading assignments given in traditional classroom settings. The intensity of concentration observed during browsing assignments indicated that students perceived a value in having new information presented in hypermedia format.

Background—Learning Style

The researcher observed two distinct student approaches to the task of browsing an ACCESS stack. For some students, the initial introduction to the stack was spent just moving from card to card, looking at diagrams, and establishing some idea of contents. This skimming process included two stacks in quick succession if the assignment involved two separate stacks. After this initial skimming process, the students using this approach went back to the main overview card of one of the stacks and began a systematic perusal, moving from strand to strand by selecting appropriate buttons.

Other students were observed approaching the task using a totally different method. For these students, the browsing process began on card one and moved in a systematic fashion from card to card, strand to strand. Buttons were activated in the order they appeared on the card working from left to right or top to bottom. Once every card in the strand had been visited, the user went back to the same overview card and used the next button in the hierarchy. These students exhibited the need to see every card in the stack and to push every button that was visible.

As discussed in chapter one of the dissertation, ACCESS was designed as a research tool at Brown University. The ACCESS program has the ability to record the card to card movement of each user if the 'student journal' function has been activated. The journal entries show the stack being used, the card visited, the button selected, and the time spent on the card.

To verify that two distinct approaches to browsing were being used, the researcher examined some of the journal entries. Ten students were randomly selected from the list of

user numbers. Entries used covered the period from October 7, 1992 to November 20, 1992. The number of separate files for any individual student ranged from 15 to 31. The journal entries varied in content and revealed that students were authoring and browsing during this time period. Entries showed that students were using time outside of class in addition to the usual class sessions to complete their activities.

The journal entries confirm what the observations had noted. For one group, a great many cards were visited in a very short period of time. After this initial process, the length of time on each card indicated a much greater interaction with the card content. These students tended to view more cards in total but often did not return to cards they saw during the initial process. When the individuals in this group were asked for an explanation, they indicated that when the material was initially skimmed, some cards were eliminated from further consideration. If the information on the card was already familiar or was material not considered useful to their work, the card name was noted. No further effort was made to carefully read the contents.

Journal entries of another group of students showed the second approach to browsing. The journal entries for these students showed that they began the browsing assignment in a structured, methodical manner. The number of cards visited was frequently less than the total in the stack. Although the stack being used at that point in the course had 134 cards, the journal entries showed only a portion of these actually being visited. The journal entries also showed that the students did not miss any of the extra information buttons on a card. In addition, they often retraced the strand and went through the same cards a second time before moving to another topic. For many students in this group, time outside of class was spent in completing the browsing assignments.

The observations and the journal entries point to the same conclusion. There are at least two distinct approaches to learning the material in a hypermedia document. One group took advantage of the freedom of choice and convenience of electronic presentations to a greater degree than the other. The second group made the choice to view the learning tool in a

more structured, more precise manner. The flexibility of hypermedia tools accommodated these two very distinct approaches to be used successfully. Students were able to interact in the manner and pace that suited their individual learning style.

Background—Authoring of Stacks

Creating ACCESS/*HyperCard* stacks emerges as a major component of the computer lab curriculum. Students experience a variety of activities designed to help in mastering the skills required in authoring stacks. The instructor has provided assignments that require students to successively add new skills. Authoring was introduced after students had had the opportunity to browse a number of stacks and become familiar with the concept of stack structure and the idea of moving with button action. The browsing assignments also provided all students the opportunity to learn to deal with the extra burden of using computers in a networked configuration.

The first stack created was the five card stack described earlier in this chapter. For this stack assignment, the students needed to learn how to open a new stack, how to create cards, what type of card to create for each purpose, how to create a button, the steps needed to link a button, and how to create a field and enter field text. This required considerable practice with many of the special authoring tools found in ACCESS. Students did not attempt any work on the computer until they had sketched the entire stack on paper index cards. With the prototype stacks completed, students could focus on the technical skills needed to complete the task. Students began their initial work on this assignment on October 6 and completed the stack by October 14, 1992. In that period of time, students had five class periods to devote to the creation of the stack.

Students were next introduced to the paint tools available in ACCESS. The graphic on the next page shows the HyperCard tools palette, the pattern palette, and the bucket tool (see figure 11). The instructor demonstrated what each tool could do by using the PCViewer and

creating a graphic as she talked. Students were taken step by step through the capabilities of each tool. The ACCESS/*HyperCard* tools palette is shown on the left and all items below the small dotted line are painting tools. The available pattern selection shows that a black pattern is selected. The graphic on the right is the bucket tool used to place patterns.

The first assignment using the ACCESS/*HyperCard* paint tools required students to create a one card stack. The card was to be a graphic drawn by the student using the paint tools. For several students, this activity was the point at which the authoring tasks gained a personal interest and value. At the end of the first session with paint tools, one student that had exhibited great difficulty in coping with the earlier lab requirements stopped to tell the instructor how much fun the class had been.

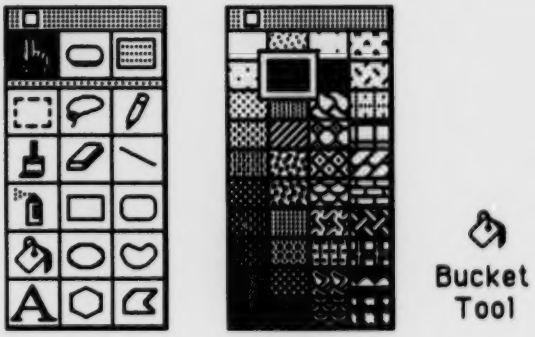


Figure 11: *HyperCard* tools, patterns, and bucket tool.

Once the students had mastered the basics skills with the paint tools, additional challenges were added. Students were given a demonstration of an animation technique which used a single button to activate the script needed for the user to move from card to card without further intervention. For the next two periods, students worked with this animation concept to create a five card stack that would show the sun rising and setting on a mountain scene. Each card was created with exactly the same mountain scene. The first card showed the

sun just visible behind the mountain. On each of the five cards, the sun was moved to a higher position in the sky.

To enhance the illusion of the rising sun, the mountain scene images were filled with successively lighter patterns . This helped to create the impression of increased light intensity as the sun rose. The selected patterns were placed into each area of the picture with the bucket tool. The pattern is placed from the very tip or hot spot of the paint hanging from the bucket tool. To keep the fill inside the chosen area, the boundary must be totally closed. Since the gray area on the right side of each ACCESS card is not protected by a solid boundary, the students had to add one. If this was not done, the fill covered the entire button panel on the right side of the card.

The students displayed considerable frustration while creating the cards. Many students experienced difficulty in placing the fill where it was intended. Placing the tip correctly was a problem for many students in the early stages of this assignment. Other students had left gaps in a boundary line or had not carried a line to the very edge of the card. This resulted in the entire card surface being covered with the fill. Several students had to redo their cards a number of times to get the correct appearance.

To complete the animation assignment, the students were shown how to script the button to control the movement of the cards. For all students, this represented the first time they had to use the HyperTalk language in the authoring process. The script contained the instructions needed to display each card in the stack with a brief pause on each card. The script included instructions to reverse the movement. Once the button was pushed to activate the script, each card was displayed in succession. This action provided the illusion of the sun rising and then sinking back to its starting position (not a true sunrise-sunset). The few lines of script needed were easily included and most students were able to complete the stack in the two class periods.

The students were next asked to create a five card stack using animation to illustrate some concept from their literature or history class. Topic choices depended on individual

interest. One student illustrated a member of the Donner party attempting to reach the summit of the Donner Pass by wading through high snow drifts. Another student illustrated the concept of social isolation discussed in the book The Hairy Ape. Both students mastered similar computer skills but produced vastly different products.

The animation assignment provided the opportunity for students to be taught new ways of creating graphics. The students were instructed on how to use the copy and paste method to import graphics from other electronic documents. In addition, a hand-out was made available that provided step-by-step instructions on how to scan an image directly into the stack using *HyperScan* and the scanner attached to the Macintosh IIsi. These options provided more flexibility for creating the graphics to be included in the stack and provided every student with the tools needed to create quality images.

The final authoring assignment for the class during the research period was introduced to students on November 26. This was a major term project done as an ACCESS stack that was to be completed for grading by February 2, 1993. Students were given the option of working individually or with partners and the requirements were flexible enough to accommodate either approach. This assignment required considerable time and effort both during and outside of class for most students. The intent and expectations for this assignment were similar to the traditional research paper familiar to most students. Students were given the freedom to select their topic to cover some subject of personal interest from within a specific historical time period. This restriction ensured that the students maintained focus on material relevant to the content of the program (see Appendix C).

The production of the term project stacks involved a number of distinct steps. Students started the process with an intensive search of available book and magazine resources to find material relevant to their topic. The list of resources used was made into a formal bibliography list using a *Microsoft Word, Version 4.0* word processor. In addition, conventional requirements for formal research papers were observed. This included the requirement of providing references for all material used directly from other sources. The content was

submitted as a word processed document. Students were expected to have used the spell checker to edit their work. The document was graded by one of the three instructors. Evaluation of the document emphasized correct writing technique and the value of the content in sharing the topic.

The next step in the process was to create a set of paper index cards that became a prototype of the research stack. The information was organized into an appropriate stack structure and cards were designed to include suitable graphics. Once the students had completed the necessary editing of the content, the index cards were used as a guide to produce the electronic cards. The content of the word processed document was brought into the stack and placed in a scrolling field. From this field, pieces of the text were selected and placed onto each card.

The task of moving text from a word processor file to a *HyperCard* stack proved to be difficult. *Microsoft Word, Version 4.0* had to be opened, the file located, and the entire document selected and copied to the clipboard. Any workstation not using multifinder—the Macintosh tool for opening more than one application at a time—then required students to close the word processor and regain entry to their ACCESS stack. Once in the stack, the text was pasted into a scrolling field created to hold the text. Finally, the text needed to be broken into smaller pieces and arranged on appropriate cards in the stack.

For many students, parts of this process were done a number of times before being successfully completed. The limitations of both the network and individual computers combined to make this step difficult. For some students, the network stopped working just at the point where the text was on the clipboard. This usually meant the content of the clipboard was lost. For other students, the size of the word processed document was too large for the computer clipboard to handle. Going through all the steps carefully and correctly didn't guarantee success. Not being able to paste the text into the stack because the machine did not have enough memory was frustrating to students and instructors.

Since the stack requirements included placing graphics into the stack, students needed to select pictures that added to their presentation. After choosing the pictures, students faced decisions on placement of the pictures to optimize the interaction of graphics and text. Some decisions resulted in adjustments to the size of the graphic by re-scanning or resizing with the paint tools. In many cases, rearranging and/or moving the text was necessary to satisfy the design demands.

The basic requirements of the assignment were within reach of all students. Optional features were allowed. Some students took advantage of the option of using animation and sound to obtain bonus marks. Students that edited the word processed content using the suggestions made by their teachers were rewarded with bonus points. Several students completed the stack by the set deadline. Most, however, needed extra time to finish the task.

Creating stacks is time consuming and the unreliable network added to the difficulty of meeting given deadlines. The students became preoccupied in different ways by the tasks. For some, the traditional research and writing skills took the larger portion of their time. Others were engrossed by the technology features used to produce an electronic hypermedia document. Since a card can be changed relatively easily, some students continued revising specific cards when they should have moved on to the next requirement. For some, finding the balance between utilizing the available time and producing a product of acceptable standard seemed difficult.

Many students had difficulty deciding the hypermedia document was completed. Comments from students and observations made by the researcher indicated that students were reluctant to consider a stack finished. This resulted in several stacks not being submitted for evaluation by the given deadline. Two students asked for an extension to provide time for them to include a new strand based on material that had been located after the initial content was composed.

> We know we could give you the stack. It does satisfy the things on the handout. But this material will make it more interesting to read. We want our stack to be really good.

Other students asked for an extension to add more graphics to their stack or to re-do a portion of the present graphics.

> We didn't like the three pictures we found first. But, we hadn't located anything else. Now we have others that we would like to use. But, we need time to move the text around.

Comments from students revealed that the students perceived a distinction between finishing a traditional written assignment and a hypermedia document. Student comments included:

> I don't want to turn the stack in yet. I know that I can add to its appearance if I redo the headings into a field instead of using paint text. Since others will read it, I want it to look good.
>
> If this were a research paper, I'd already be done. I wouldn't have to worry about what it looked like. But I want others to like my stack.

Comments made by several students reflected this perception that a finished state in a written assignment was less demanding to reach than was a completed state of stack. One student even suggested that when he was doing a traditional written assignment, the job was done when he had enough pages. It didn't matter what was said or what the writing looked like. The written product was considered necessary only to fulfill the teacher's request. The hypermedia product had to also satisfy the demands of anyone that might want to use the stack.

At the completion of the term project, the teachers created a questionnaire to ask students to reflect on the assignment that had been given. This questionnaire is included (see Appendix D). The table on the next page shows some of the results (see Table 7).

The table shows the results of question five. This question was designed to determine what parts of the term project students felt should have had greater attention. If the students were to do the same assignment again, 16 felt that they would definitely spend more time on producing the textual content of the stack. Seventeen students indicated that they would spend more time on the appearance and design features of their stack and less on textual content. All 33 students indicated they would put a greater effort into their work earlier and that they

Table 7. Teacher Conducted Questionnaire on Term Project Experience

Question and sample responses	Significant Number Responding
1. What was the one thing you found most rewarding as your created your research stack?	
I made it myself	
using new software	
increased computer skills	
freedom of organization and order of presentation	
becoming an expert on my topic	
actually finishing	
3. List the new skills you learned as you created your research stack.	
how to transfer text from Microsoft Word 4.0 to ACCESS	21 of 42
keyboard shortcuts	
how to create buttons that occur in error	
digital pictures from the Xap Camera and Computer Eyes	
5. Thinking in terms of the time you used to complete your research stack assignment what task(s) would you spend more time on if you were to do the job again?	
content and research material	16 of 42
design and appearance	17 of 42
links and annotations	
scanning and sound	
6. As you consider the way in which you organized your time and approached the steps needed to complete your research stack, what would you do differently if you could do the job over again from start to finish?	
place the scanned images first and then put the text in place	
scan the images onto cards actually in the stack and not have to move them	
more careful planning of each card at the index card level	
spend more time when the assignment is first given, not do it all at the end	

wouldfind a way to spend more time at the computer. In addition, each student had at least one suggestion they would personally follow to make the process easier a second time.

Specific Categories Identified In Collected Data

Category I—Part One—Providing the Motivation to Learn

The literature review in chapter two looked at the issue of student motivation. Researchers indicate that students with the desire to learn and willingness to direct their own learning become more successful than students relying on teachers for motivation (Jones et al, 1987). One of the inherent qualities in the hypermedia learning environment is the need for students to be actively engaged in learning. While using hypermedia, students had to stay involved and active in order to maintain orientation in the stack structure and content. Students could control the rate at which the information was displayed and made decisions as to what information would be viewed next. The electronic format of the presentation made this easy and convenient to do.

Most students recognized a number of advantages in learning from hypermedia products rather than print material. These students state very definitely that learning from hypermedia products was an enjoyable and rewarding experience.

> I like the variety of the things we get to learn. Sound and pictures sure make it different.

> I don't find my mind drifting away. I don't even realize I'm working hard until I see that time has gone by.

I like to control where I go. I don't have to read stuff I don't want to. I just skip over it.

The participants of this study perceived a difference in the manner in which learning took place in this hypermedia environment compared to the traditional approach that is normally been presented to them.

Motivation—Organization of information

Data obtained from discussions with students and on the student questionnaires completed in January provided evidence that the students felt motivated to learn from their hypermedia tools. The manner in which the information was presented in the ACCESS stacks appeared to be helping them maintain their motivation to learn. Although the material was available only one card at a time, the ease of the electronic interaction moved them quickly from one piece of information to another. The students in the study indicated they felt comfortable interacting with the information in this manner.

Students recognized there was a difference in the way the text was written when compared to books but preferred the hypermedia style of writing. The need to 'chunk' information to fit with screen by screen presentation required a slightly different writing style than traditional books contain. The precise, somewhat condensed style used in the hypermedia presentation was perceived by students as easier to read and remember. The opportunity to omit the transitional writing required in a traditional linear presentation was appreciated. The writing mechanics used in the stacks was preferred by the majority of students to the writing style used in their textbooks. The task of reading, understanding, and remembering the information seemed easier in the hypermedia format. Comments included:

> Information is presented in smaller, more organized chunks and not long and boring as in text books.
>
> I like how the information is separated for instance, they have about a person, things the person may have done, influences of the person on society, etc. The information is well organized and presented in different categories.
>
> I can learn faster with stacks and I understand the information more.
>
> Information is given in chunks that I can absorb. I don't have to bother with a great deal of extra information.
>
> I get more excited about learning and when it comes time to take the test, I feel like I know the information better.

Students identified the unique ability of a hypermedia document to be nonlinear in organization as an advantage in developing an understanding of the material. The electronic links allowed the students to move through the document in an order of their own choosing. These links gave a constant illustration and reminder of the association of the ideas in the stack. As the students became familiar with the design elements of ACCESS stacks, they began to discern the value of the linking function. Their comments included:

> I find it easier to understand the connections in different topics.
>
> The idea of strands give the indication that certain subjects are linked to one another in certain ways.
>
> I like the links and the different way to connect things. You can just skip around.

Many of the students felt the actual structure of the presented material was by itself providing a key concept. The associations were not simply implied; the associations were demonstrated.

The students took advantage of the clarity of association once they gained sufficient understanding of the technical aspects of stack construction. One student remarked:

> Until I began to author my own stacks I didn't realize how much information is given by the way you put the information down. You constantly tell the reader what you like, dislike, feel is important, feel is trivial, just by where you write the sentence.

For many students, the illustration of the connections that prevail in hypermedia presentations served as guidelines as they learned new concepts. The structure helped them visualize and organize the material. Many students indicated they felt their own ability to understand and perceive connections in information being learned in the hypermedia environment and in other classroom situations had increased from experiencing the format of hypermedia learning tools.

Motivation—Graphics

Information in a hypermedia environment is given in a variety of media. This quality gives hypermedia learning tools the power to satisfy a wide range of learning styles. Rather than depending on primarily textual sources, learning in a hypermedia environment benefited

from several simultaneous approaches. This integration of various communication forms was perceived by students as helpful to their learning task and resulted in the learning being more enjoyable.

> I am a visual learner so the graphics helped me to learn better.
>
> One of the most helpful things was the abundance of scanned images.
>
> Animated pictures and the fade in and fade out features help maintain my interest.
>
> Animation and sound help me learn.
>
> I retain the information easier and longer because the visuals stick in my head.
>
> Pictures and music help create a tone and an image of the history.
>
> Being able to associate the text with graphics and sound makes it easier to remember.
>
> The stacks use lots of pictures and I seem to remember the text better.

Many of the students gained an awareness of the fact that some concepts need the benefit of a picture to offset the limits of verbal description.

> Often times, in a book, you would not be able to get a visual picture of the concept you are studying.

When asked to clarify this comment, the student explained that when one discussed a concept such as changes in fashion, a few pictures removed the chance of miscommunication and saved a tremendous amount of writing. The learner had access to the same visual picture the author used when the description began. This clarity in communication eliminated learner error and time. Another student said:

> Even having the picture of the person being discussed makes the information more interesting and then easier to remember. It makes the person more real and the information given is more valued.

With the variety of communication forms readily available in the ACCESS hypermedia learning environment, the material easily met the needs of a wide range of learners. The electronic presentation allowed support for learners who are primarily visual without preventing the presentation being equally effective for learning styles that are primarily auditory or kinesthetic.

Motivation—Novelty of Computers

The students in this study admitted that part of their enjoyment in authoring using hypermedia learning tools was the novelty of the technology. The fascination of the technical tools often carried the students into learning situations that could be considered complex. The students learned to select and place scanned images and recorded their own comments into a stack. Many students shared the comment:

> I was having so much fun trying to get the pictures to look just the way I wanted that I forgot what the time was.

Finding graphics that would be helpful to the communication and determining which size was best suited to the presentation required constant decisions. These decisions kept the students actively involved with the information for longer periods of time than was observed when the same students were using traditional book materials. A student said:

> Since I learned to place sounds into my stack, I always "hear" the information in my mind, even when I just read it. I think I remember it longer because I have it "taped" in my head.

The researcher spent some time gathering data as students learned new information from hypermedia and traditional presentations. Students were observed learning new concepts from an ACCESS stack and observed learning new concepts from a novel. The behavior pattern in the two settings was considerably different. Several students displayed evidence that indicated sustained interest in their books was difficult. These same students were seen on task and browsing a stack for a much longer period of time.

The notes from classroom observations produced the following comparisons when data from several different days was merged. During three successive classroom observations, the researcher sat where the same three boys happened to be in direct view. During the classroom observations, the three students were doing silent reading in the required novel. During the first observation period, the students were reading The Awakening by Kate Chopin. During

the other two observations, the boys were reading Their Eyes were Watching God by Zora Neale Hurston.

The researcher recorded the observable behavior exhibited by the three boys as they did their reading. Behavior patterns were noted that indicated the students had lost their concentration while reading. The list of such behavior included looking for something in a backpack or binder, gazing across the room at the items posted on the wall, talking to others, drawing on the desktop, ripping paper, turning to look out the door or window, and opening and closing the book. Behavior suggesting being on task included having the book open, writing in a notebook, having their eyes focused on material that could be construed as material required for the task, and turning pages at acceptable intervals.

In addition to behavioral notations, time intervals were recorded for the duration of on task behavior. The boys' average on task time was only eight minutes. One of the three boys was not observed on task longer than three minutes 25 seconds. The longest time interval recorded was 16 minutes. The student with this time record tended to spend longer intervals doing his work, but he also spent longer intervals in other behavior than was recorded for the other two individuals.

To make similar observations possible in the lab, the instructor was asked to seat these three students in close proximity to each other for several lab classes. Observations were made during three computer class periods when the students were browsing ACCESS stacks to complete a general assignment involving the information in the stack.

The behavior and time period results were considerably different. Activity considered by the researcher to indicate the student was no longer working included leaving the computer to walk around the room, stopping to talk with others, and having screen information visible that was not recognized as being part of the stack needed to complete the work. On task behavior included visual contact with the screen, screen displays that changed but were still part of the required stack, the use of the note taking feature to record notes, and reading the assignment sheet that outlined the required tasks. The person having the greatest trouble

staying on task during the traditional reading task was able to sustain concentration for an average of 18 minutes without apparent distraction. The average on task time interval for the three students over a three class period was 27 minutes. All observations were done during a 50 minute class period.

This 'mini study' was suggestive but is by no means definitive. Observation of the work done using the computer during this time was prone to error. Some of the activity at the computer may not be specific to the learning task and was counted as on task by the external observer. Having the same screen visible for a certain period of time may indicate that the student was simply not reading anything at all rather than actually attending to the task. Also, a screen recorded as visible for a length of time may not have been constantly present. The student may have left the screen, viewed something different, and returned. The observer may have missed the change of screens. Behavior may be classified incorrectly if part of the behavior was not observed. Electronic presentations move at a speed that made it difficult to observe more than one person at a time.

Off task behavior was more visible. The three students did not exhibit the behavior of gazing around the room, turning to question their neighbor, reaching into their backpacks for something, physically fidgeting in their chair, or putting their heads down on their table top. This suggested that their attention during the lab activity was kept focused and could be sustained for a considerable length of time.

All students were asked to comment on their perception of the advantages to computer based learning over book based learning. Student comments varied but are primarily positive in nature.

> I think it makes it a lot more enjoyable to find the information on the computer, rather than spending much more time finding the same information in a book. It makes learning the information a lot more exciting. Especially when we get to create our own stacks.

> Since they were on the computer, it kept me interested. I never would have learned so much out of a textbook. We were left to do the work at our own pace.

> Going to the lab makes the reading more exciting and also it gives more of a variety than sitting down and just reading a handout on the material.
>
> A lot of the time, I'll read an entire chapter out of a text, then realize I have no idea what I just read. Browsing stacks makes it almost fun to learn!
>
> I enjoy the fact that there is more interaction with the *HyperCard* stacks, and I remember things more, perhaps because I pay more attention to computers than to books.

Students appeared to openly share their response to the technology based class presentation. The lab activities and organization were viewed as less formal than their other classrooms.

In the lab setting, collaboration seemed to occur without planning. Students felt more comfortable about asking questions of the instructor and of each other. The students felt free to make comments, express their own opinions, or share something of personal interest. Informal cooperative groups formed on the basis of having classmates within easy hearing distance engaged in verbalizing reactions and questions. The relaxed atmosphere exerted less pressure on students. Being able to progress through the information in a personally selected order and meeting information in a variety of forms was viewed as an advantage by most of the students.

Motivation—Ease of Finding Information

The electronic presentation of information provided conveniences not available in traditional book formats. Students liked the electronic ability of moving from one chunk of information to another quickly and easily. The ease of interacting with information and selecting the parts of the presentation of most interest were perceived as decreasing the time needed to learn new concepts. Students liked the control the hypermedia format provided over the order in which the information could be read. The information blended to give a picture that included more than a single perspective.

> When learning about Victorian times, we were able to look at other aspects more in depth that interested us personally.
>
> We were able to see that there is a lot more involved in specific time periods than you might think at first.

> The stacks had the most important information regarding the topic. I didn't have to look through lots of books, the button told me where the next subjects were.
>
> Give the opportunity to gain more in-depth understanding of the Macintosh computers and showed us there were different ways of getting information other than that we've been accustomed to.

This group of learners expressed a growing awareness of the many methods of conveying the same information and realized that some choices are more effective in communication than others. The ease with which information was handled electronically provided an incentive to continue work. Traditional presentations were not perceived in the same way. One student explained that if the books from the library were the only tools available for the assignments, the assignments would never be done.

Motivation—User Choice and Freedom

Educators have recognized that keeping students actively involved in their own learning is critical to the success of the learning. Learners who make decisions about how their own learning will be done and stay actively involved during the learning process show distinct advantages over the passive learner. Most of the students involved in this study felt that decisions about the options hypermedia documents provided were helpful in maintaining their attention.

> I can choose where I want to begin in the stack and then travel on any path of strands and cards that I want.
>
> I like having the buttons so you can go where you want to go quickly.
>
> We were able to look through the information at our own pace and we could look through the strands that interested us personally. Also, it was just fun to learn from a computer.

Having the buttons to select, seeing the visual effects unfold, and mentally checking the result of the button action kept their interest and concentration levels high. Many students especially appreciated feeling that their learning was being directed to a great extent by themselves.

A note taking feature is included in ACCESS and is conveniently placed for use in any stack. The students felt that taking notes during the reading process and then having the notes for later reference helped them stay actively involved with the information.

> Looking for key pieces to write into the notes makes me pay more attention to what I do read. I am always aware that each card may give me something more of value.

Students commented that the requirements of taking notes was becoming a habit for them and often when working away from the computer, hand notes were written. A number of the boys in the research group indicated that they had never taken written notes before. In the lab setting where note taking was an accepted and expected activity, these students began to take notes. The boys commented that they were initially embarrassed about the idea of note taking. Since everyone else was doing so and the assignment required the notes to be submitted, this feeling was soon lost. Since realizing the notes were helping them remember the information, the boys now use this approach to learning new concepts in other classes.

Category I—Part Two—Factors Limit Motivation to Learn

Not every student shared the same viewpoint of their hypermedia learning experience. In addition to the many positive comments, some students indicated they encountered negative aspects in their hypermedia environment. These limitations should be considered as critical to the assessment of hypermedia's potential as are the positive aspects. The students reported problems created by poor design choices in the stacks provided, by difficult vocabulary in the text, and by the restriction having to be in a computer environment to use the resources.

Limits—Design Flaws in the Stacks

The process of learning from hypermedia brought students to a new level of awareness of how information was shared. They gained an understanding of the complexity of

communicating new ideas to others. As the students' understanding of stack design increased, their willingness to accept some of the irritating flaws in the hypermedia presentation decreased. As their expertise in authoring stacks grew, their tolerance of poor design choices diminished.

Some of the problems perceived are limitations of the technology. The small portion of information available for viewing at any given time was frustrating. Quality of monitors and choice of fonts greatly affected the ability of the user to read text easily and quickly. The speed at which the network or workstation computer could handle the information decreased the efficiency of learning. Student comments reflected some of their misgivings about learning from hypermedia.

> Hard to read things from the screen and can get lost and miss part of the stack.
>
> Sometimes when you click to go to the next page, it takes so long to get there, you forget what you were just reading.
>
> Avoid long and boring strands. Make it feel like you are using a computer, not reading a book.
>
> Break very large strands into a couple of smaller strands.

Reaction to the length of presentation may be partly the result of the way these students spend their leisure time. Many students spend a great deal of time in front of a television set where information is presented in short, intense bursts. Dealing with only short bits of material becomes an established habit. The learning style developed may not tolerate the longer, more sustained presentation of both books and some of the ACCESS stacks.

Many of the students suggested that the material would be easier to learn if the stacks gave a short summary of the material in each strand on the opening card of the strand. Some learners felt that they worked best from having a general idea of the material before working into the more detailed aspects of the concept. For these learners, an introductory summary would undoubtedly be helpful. Since the user must move through a number of cards and the concept may be spread over several screens, the overall concept is vulnerable to distraction. One student mentioned:

> If I don't get interrupted or encounter a button that intrigues me, I do just fine, but otherwise I break my train of thought and sometimes I feel I never create the full picture being given me.

Limits—Choice of Vocabulary

The ACCESS stacks being used as resources were created by teachers with a number of years experience in the classroom. The choice of vocabulary reflects their level of expertise. Students are very much aware of their own limitations and level of expertise when reading the actual words of the text. While students recognized the need to increase their vocabulary, they felt there was a limit to how much new material could be handled at any one time. A frequent complaint from students using the ACCESS stack resources was their inability to understand what was said because of choice of words or actual sentence construction.

> Some of the information used too many big words that didn't fit together well and the stack became confusing.
>
> Use words that we've heard of. There were some weird words in a few of the stacks.
>
> Simply some of the vocabulary.
>
> Use easier words to help us understand the concept easier.

The text illustrated in the graphic on the next page is taken from a card in the Gilded Age stack (see figure 12). This card is one of seven in a strand containing information on Henry George. Using *Microsoft Word, Version 5.0*, a readability rating was conducted on the strand. The Flesch Reading Ease rating of 49.0 is considered fairly difficult. In addition, the Flesch Grade Level was given at 13.1 and can be considered a challenge to students at this level.

Other reading problems were identified by the students. The number of very long sentences in the text adds to the reading difficulty. The Henry George strand of seven cards contains a total of 48 sentences with an average of 22 words per sentence. The Gunning Fog Index which evaluates the writing based on sentence length and the number of syllables in

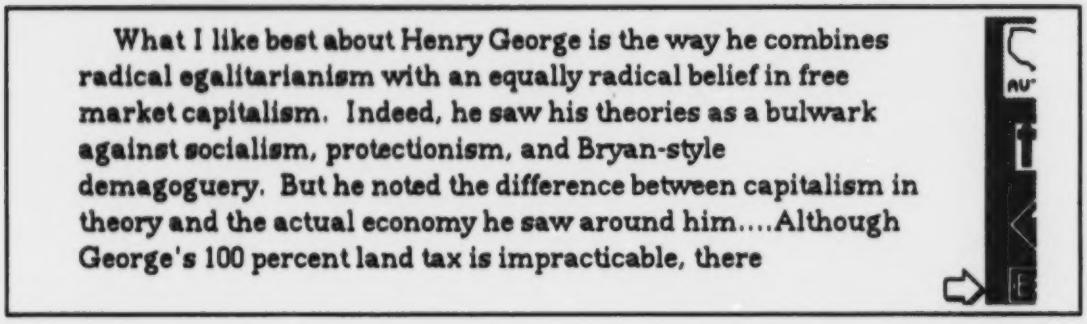

What I like best about Henry George is the way he combines radical egalitarianism with an equally radical belief in free market capitalism. Indeed, he saw his theories as a bulwark against socialism, protectionism, and Bryan-style demagoguery. But he noted the difference between capitalism in theory and the actual economy he saw around him....Although George's 100 percent land tax is impracticable, there

Figure 12: Sample writing from ACCESS stack.

words was 13.6. This rating is considered an advanced level. In addition to the technical writing problems, the design choices in the stack added difficulty. The card used in the example is one of the 190 cards in the 289 card stack that included nothing but text.

Complaints about the vocabulary level and writing style were heard frequently throughout the entire research period. Student need to consult a dictionary or seek assistance did not diminish during the research period. Online dictionary assistance could have added to the convenience of the hypermedia presentation. As students began to display a more responsible attitude towards mastering the concepts, the use of extra resources was observed to increase in frequency. A number of dictionaries were available in the lab for student use. These were frequently used by students and instructors during the browsing activities.

As students gained confidence in their understanding of what a stack could and should do, they began to express other valid complaints.

> Sometimes the information in the stack is inaccurate and also, the stacks don't always have all the information you are looking for.
>
> Often the stack did not contain many pictures and became boring to use.
>
> Sometimes I felt like the information was just stuck there. I didn't know where it came from. I didn't always understand some things, so there wasn't always good background information on all stacks.
>
> The information is not presented in a way that makes me want to read it. It is just messily put together and I keep getting distracted by the unpleasant appearance it has.

Limits—Resource Restricted to Electronic Presentation

The fact that ACCESS stacks existed only as a computer based learning tool provided another area of students dissatisfaction. There were some obvious limitations to relying on an electronic product for learning the information.

> The material is not available at all times. You couldn't take the program or use it at home to review it. You can only use the program when at school and the lab is available.
>
> The ACCESS stacks could not be taken anywhere else. You could not refer back to it unless you took notes.

While the issue of creating notes forced learners to be active and were perceived by most students as helpful, the inflexibility of the product created some frustration for them.

Some of the ACCESS stacks are somewhat linear in structure. For many students, their comments reflected that they did not find linear presentation either an interesting or an efficient way to learn.

> Strands with few side strands or images become boring and are not read as carefully.
>
> The longer the stacks were the more bored I got.
>
> Break the very large strands into smaller pieces. That would be more interesting to read.
>
> Don't make the strands be so long.
>
> The only suggestion I have [for improving the stacks] is to avoid long and boring strands. Make it feel like you are using a computer, not reading a book.

The previous complaint may be a reaction to a conflict with their own learning style. Many of the students saw the length of the product as a negative quality in hypermedia. While most of the stacks in use by students are not large, stacks of over 200 cards which also have design flaws were viewed as being "too long and boring" by a number of students. Strands that have 14 cards of successive text with no break are difficult to read and comprehend. Stacks that include many buttons that force more decisions from the user were preferred as they were more interactive and interest was easily maintained.

Category II—Navigation

A great deal of the literature reviewed in the second chapter of this dissertation deals with the issue of navigation within hypermedia documents. This issue appeared to be less of a problem from the students perspective than was anticipated based on the comments found in the current literature. The possibility of getting lost in a stack is very real. On the January questionnaire, one question specifically asked students to indicate if they had been lost in a stack. Of the total number that responded, half indicated they had had the experience of being lost. Most of this group understood being lost in a stack as finding themselves in a place they did not recognize in relation to where they had been or wanted to be.

> I'll push on a button and end up in an entirely different strand and I don't know how I got there or how to get back.
>
> When I got to the end of a strand and I pushed the arrow button, it took me to a completely new strand and I got lost. Also, once I ended up in a completely new stack and couldn't find my way back.
>
> I was far into about two or three strands and I wanted to go back to another strand because I hadn't finished taking notes on it yet. I tried going back and keep on going to the wrong card and strand.

Most students have developed a strategy to cope with this disorientation. In most cases, students solved this problem by using the go recent function and moving back to a card position which they recognized and where they felt comfortable. Others used the keyboard command to move to the first card in the stack and then returned to the overview card containing the selection of choices. Although they commented that time was lost, they did not feel frustrated or concerned.

The students expressed the view that they had ample methods for coping with this situation. The coping strategies they used are efficient in this environment where the hypermedia documents are small. For much larger hypermedia products, this particular issue might have produced different results.

Another interpretation to the concept of being lost was used by student. Some students felt being lost was the result of the user misreading the cues being given or the cues themselves being ineffective. Disorientation in this sense was the result of the readers inability to understand the cues or poor choices of cues used the author.

> Sometimes the link arrows or other arrows take me to the wrong places.
>
> I can never tell exactly where a button will take me and what the connection really is.
>
> The action of a button doesn't always make sense.
>
> Sometimes I think I have an idea of where I will be and the result doesn't match that idea.
>
> Sometimes I can't figure out why the button had the name it had because it didn't really relate to the strand.

When asking students to clarify the preceding comments, the explanation always included the idea that the button name, context of the button, and the included graphics and text provided guidance for what would be contained at the next level. If the stack design contradicted the established pattern, students found the results distracting and felt lost in a thinking context rather than a stack structure sense. This disorientation appeared to create greater frustration for students than does the location problem. As one student stated:

> The stack author spent 100 cards teaching me that the plan he followed was put together in a certain way. Then I started hitting buttons that didn't do what they usually do. Topic buttons didn't take me back to the previous overview. I ended up in another stack. The named link put me on a card that had a name not even remotely similar to the button name. I really wondered why he jumbled everything up. Maybe he didn't understand what his concept was either.

Navigation—Map Card

One of the options that can be included in hypermedia presentations is a map of the document itself. The map of the document is able to provide the user with a number of key pieces of information. The map contains a visual presentation of the organization of the

material. Before actually moving into the document, the user can study the map and begin to formulate a mental picture of the stack's structure.

The map also provides the user with some basic information on the content of the document. The key words used to identify major nodes gives the user cues as to what information is included and where to find the material. The associations between topics are visible when the links are shown and the length of each strand can be included. A map card was a requirement for all stacks created by the students in the research group. The example on the following page is the map card from the Native American stack used as a resource stack (see figure 14).

Although many of the stacks being used by this group of students did not have a map card, many students wanted one added. The students expressed the view that the map card provided them with an aid to learning the structure of the stack and hence prevented them from wasting time being lost in the document. Also, the map card provided them with an actual model to start the organization of the information in their minds.

> The map card is the very barest of outlines of all the material in the stack. Once I can remember how the map goes together, I can put the information I'm learning into a form I can remember.
>
> I look to see which strands I can got to, and if possible, I go first to the map card.
>
> I look first at the map card to find out what the stack or the subject consists of.

Navigation—Go Recent Function

HyperCard provides the user with a go recent feature that opens a window and displays a miniature version of the last 42 cards visited in the stack. The user can then move directly to any of the cards displayed by simply clicking on the desired card image. Students viewed the go recent function of *HyperCard* as the easiest way to move to a position in the stack they could recognize. This device prevented many students from ever feeling as if they were lost. The second graphic on the next page displays part of the go recent window after a total of 24

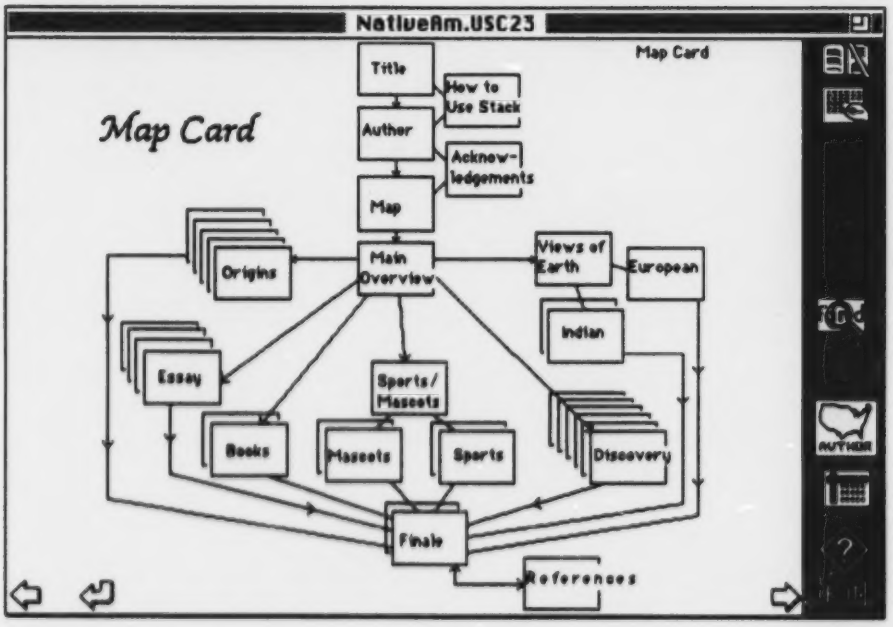


Figure 13: Sample student map card.

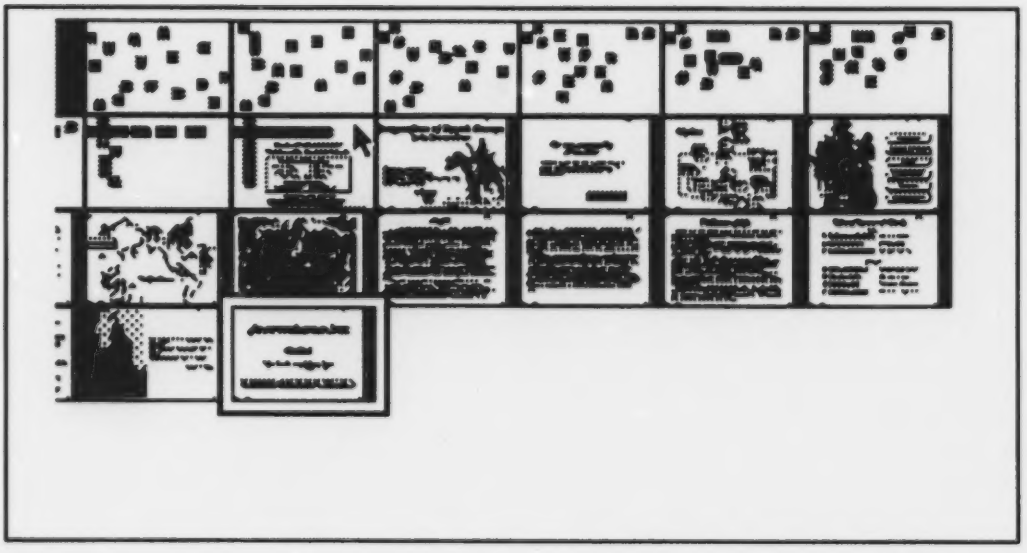


Figure 14: The go recent window in *HyperCard*.

BEST COPY AVAILABLE

cards had been viewed (see figure 14). The small rectangle around the last card in the display indicates the viewer's present position.

Students realized that the option of using go recent was always available to them. If a particular screen reached was not the desired material, this strategy provided an immediate solution for moving elsewhere. This coping strategy for navigation was fast and worked well for most of the stacks these students used. However, once the full 42 cards are placed in the window, only the most current choices remain visible. In some cases, the students found they were forced into an alternative method since the card they wanted to return to was no longer visible. For stacks that are larger in size, this coping strategy does not provide them with the assistance needed.

Navigation—Search Feature

ACCESS includes a find button that uses *HyperCard's* ability to search the stack to locate specific items. The find feature of ACCESS allows the user to enter a key word or phrase and initiate a search of any designated stack. As the computer encounters the word or phrase, the name of the card containing the search item is added to a list. On the completion of the search process, the user has a list of all cards which contained the word or phrase. By selecting a specific card from the list, the user is able to move directly to the desired information. This find feature in ACCESS is slightly more powerful than what *HyperCard* alone would provide, but speed is limited by the power of the machine being used.

The find feature was seldom invoked by students. The time required for the list of cards to be created is considerable. When directly asked about using the find feature, several students stated that they had forgotten how to use it or had difficulty in picking a word or phrase that resulted in an efficient search. Other strategies were preferred such as returning to the map card, skimming the stack and overview cards, or asking someone for assistance in

locating the item. Only when there appeared to be no other method available were students observed using the find feature during their work.

The find feature provides a rather uncomfortable environment for the user. Once the key word or phrase has been entered and the stack names to be searched are selected, the user sits with a message on the screen (see figure 15). There is absolutely no way for the user to gain any information on the progress of the search.

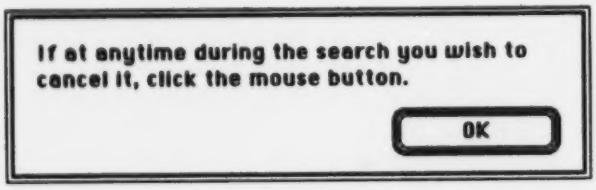


Figure 15: The search dialogue box.

In an attempt to gain more specific information about the find feature, the researcher conducted a timed test on a Macintosh IIsi stand alone workstation. Using the search phrase George Henry, the find feature was activated on the Gilded Age stack. The researcher let the search continue for 30 minutes before pushing the button which is displayed on the above graphic. The 30 minute search had produced a list of nine cards containing the name George Henry.

Prior to using the list to view any of the cards, the researcher searched the Gilded Age stack for George Henry using an alternative method. The researcher went to the opening card of the stack which provides a number of buttons. By selecting buttons that were perceived as possible links to information on George Henry, a list of cards that contained the name was created in only four minutes. The search was conducted by skimming overview cards, following what seemed to be logical strands for the topic, and using the go recent function to return to a needed overview card.

A comparison of the two lists was done. The find feature had located a total of nine cards in 30 minutes. The alternative method produced eight of the same nine cards in only four minutes of work. The Macintosh IIsi as a stand alone machine is undoubtedly faster than a similar search would be in networked conditions. Based on this very informal mini study, the value of including a find feature can be questioned. However, the stacks used in this study are small and the students can conduct a quick search by viewing the cards. In a larger hypermedia product, the student developed method of searching for a particular reference would not necessarily be effective.

Category III—Personal Ownership

The students involved in this research study displayed substantial pride in the work they produced in the computer lab. The students said they spent more time on their computer products than they did on an equivalent written assignment for this program or other classes. Students frequently volunteered to have their work viewed by the class using the PCViewer. In addition, the students freely shared their thoughts about what they were trying to accomplish, how they went about creating the stack, and which parts of the task created trouble for them. The feedback received from their classmates and instructors was perceived as a reward for their work. As a result, the students put greater effort into producing work of high quality than did in completing a written assignment.

Hypermedia products are by nature more public than traditional assignments. Having the work displayed on a computer monitor in the lab eliminates the privacy that students can maintain with a written assignment. Classmates and instructors are able to see the work as it is being produced. Students soon realize they can include good quality graphics even if they do not consider themselves to be artistic. The group was able to include sound resources with minimal technology skills. The quality of the final product depends on more than just writing ability and students appear more willing to spend the time and effort necessary to produce

outstanding work. Student effort is rewarded with constant feedback rather than just a grade given by the teacher at the completion of the work. Many students commented that they enjoyed producing assignments that were shared with others and not just read by a teacher and immediately discarded.

Personal Ownership—An Example

One student in particular demonstrated the value of having students produce their own hypermedia product. This particular student exhibited some difficulty in adjusting to the demands of the USC program. Although the computer was perceived as an interesting tool, the student had no concept of why the computer was being used. When the introduction to the paint tools and animation features was completed, this particular student displayed a dramatic change of attitude towards her work. From a reluctant participant in many of the activities, she became a willing leader and began to assist others in learning new computer skills. At her invitation, her animation stack was shared individually with her teachers and other class members. She was the first one to complete the stack requirements and to submit her work for evaluation. She also suggested that several of the animation stacks be shared using the PCViewer and volunteered to begin the process herself.

The same student illustrated the pride of ownership inherent in the hypermedia documents in another way. The researcher kept the Macintosh lab open late one Friday evening to provide extra lab time to the students. Early in the evening, this student arrived with her parents to share the stacks she had created. For over an hour, the three family members sat in front of a computer and quietly shared the work that she had done. The mother commented:

> We have heard so much about these stacks. The research stack has been the topic of conversation at the supper table every night for the last three weeks. It has been exciting to hear about and even more fun to see. I now understand what she means about animated pictures. I can see how much more informative the final product is as a stack that includes pictures and sound along with the words. I read her content paper.

> The completed stack is much more interesting. But, I think she has included only half of what she actually learned about her topic.

The challenge students faced in the term project was considerable and most students found that task took a great deal of time and effort. Teachers gave the students an opportunity to answer a number of questions about the assignment. The very first question reads "What was the one thing you found most rewarding as you created your research stack?" Comments by students included:

> Having a completed piece of information for everyone to look at.
>
> Feeling like I'd completed a big project that was interesting and had good information.
>
> That other people would be able to read it and get something out of it.

Personal Ownership—Shared Successes

In the context of the computer lab, students were given immediate feedback from a number of sources. When students completed some portion of the assignment in a unique or unusual way, another student was bound to notice. Comments overhead varied but included:

> Hey, that is neat. How did you do that?
>
> Wow, that is something. That looks really great. Tell me what you did to get that in your stack.
>
> I like your picture. I think it really adds to your information. When you scanned the image did you have to resize or change anything?

In many cases, the student became an instructor and shared the expertise they had gained. The interaction in the lab setting fostered an attitude of sharing and cooperation. When one student noticed another having difficulty, they offered to help if they felt they had the skill that was needed.

Many students were reluctant to stand in front of the group and express their own thoughts. Early in this study, one girl in particular displayed body language that indicated her discomfort in the group. She would arrive in the classroom and immediately sit at her

computer. She did not greet students or teachers. She would not make eye contact with those around her and never asked for assistance. When the instructor stopped to check her progress, she displayed increased discomfort and attempted to physically turn away.

After a number of weeks, some changes were noted. First, the student was becoming increasingly competent with the basic steps needed to browse and author ACCESS stacks. Her computer skills had increased to where she no longer found herself struggling to complete even the most basic requirement. For the first stack using pictures, this particular student began to produce work that was noticed and commented on by the students sitting near her. She began to sit with her head erect and no longer hunched her shoulders. After 12 weeks in the USC program, this student was observed by the lab instructor answering questions for another student and demonstrating a number of computer skills the other student needed to complete the work. This marked an incredible change from the beginning of the year.

This student now shows an entirely different personality in class from what she displayed at the beginning of the year. She no longer sits and isolates herself from the other students. Eye contact is made and as the student enters the room she greets the teacher. She often arrives early to class and carries on an informal conversation with the instructor or lab assistant. This same behavior change is evident in all aspects of the program, not just the lab time. She has gained confidence in herself socially, as a computer student, and as a member of the USC program. The products she produces for evaluation have become better and better. Her ability to combine graphics and text is providing an example that other students are trying to follow. This student recently commented:

> I really enjoy the chance to work with the computer. Knowing that I don't have to try to explain all my ideas just with words has made it so much easier to complete my work. I like being able to help someone else. I know that much of what I have learned was done by watching others. It is great to think I can now help. My writing isn't always really good but I do know that with the pictures and text I can explain most everything I want to.

In January, two new students joined the group. This student took a leading role in helping the newcomers to learn the technology skills and to fit into the social structure of the

group. The combination of personal success, positive feedback, and constant encouragement from peers and instructors helped this student gain self respect and self confidence.

Category IV—Interaction Between Authoring and Browsing

The group of students involved in this research project benefit from previous work done by students and teachers. Stacks authored in previous years by teachers and students involved in Brown University's research project cover many topics included in the USC course of studies. Input gathered from the authoring process has resulted in a number of revisions to ACCESS. The participants of the present study are using a version of ACCESS that has been revised and improved from the initial product.

Browsing and Authoring

Students use ACCESS to engage in two primary activities—browsing and authoring. Students in the research study indicate that the two activities within the hypermedia environment provide quite different experiences. The researcher noted during informal conversation with several students in the group that the students seemed very unaware of just which stacks had been used for browsing and what the actual stack names were. Yet, each student could name and describe every stack they had personally produced. Confirmation of this conclusion was obtained from student answers on the January questionnaire.

Students appear to be much more personally committed to stacks that they author than to stacks used for browsing. In addition to being familiar with their personal stacks in terms of names and general size, each student was able to provide an excellent synopsis of the information in their stack. For many students, discussion with the researcher produced considerable additional information the student had learned but had chosen not to include in the stack.

One of the classroom activities in January involved the sharing of the term project stacks the students had been working on. The two students who created a stack on the Wright brothers taught the entire class about the geography of the area selected for the test flights of the Kitty Hawk—the first plane the Wright Brothers managed to successfully fly. In addition to having a gradual slope that eased the task of moving the plane rapidly enough to take flight, the prevailing winds were perfect for the job. None of this detail was included in the stack. The two students said:

> We couldn't put in everything. But we thought it was a neat concept and we had often wondered why one location was used over another. But, we felt that more important things were needed for someone just learning about the subject.

Student authors show an expertise in their chosen topic that far exceeds their expertise on topics learned from browsing a stack. The participants in this study answered questions related to their stack topics in much greater detail than questions on topics that were merely browsed. Each member of the group showed tremendous confidence during discussions covering the topic they had personally researched for authoring a stack. This confidence was not observed during similar discussions on topics encountered during browsing assignments.

The students indicated the work done on the term projects provided a feeling of power that resulted from their ability to share or teach something to the others. The researcher noted that particular students volunteered information when classroom discussion revolved around their area of research. Each student gained the ability to suggest where others might look for further information on the topic used for the term project. In addition to the information in the person's stack, several other sources could be named. These included books, magazines, and films that related to their topics.

Student expertise was noted by the instructors and used to help instruct the class. Classmates showed an appreciation of the resources available within the student group and gave each other considerable recognition. In addition, students recognized their own expertise as illustrated in the following:

> I learned a great deal about the subject I was working on and I learned a lot of new computer tricks.
>
> I found out a lot of information on something that I was very interested in.
>
> I became an expert on my own topic—the Spanish American War.
>
> On this one concept, I enjoyed knowing that I had more information than anyone else in the room and when someone wanted help, they would come to ask me.

Authoring kept the students actively involved with a topic for a considerable length of time and the interaction with the information was done on a variety of levels. As one student commented:

> First you have to read the information selecting what you feel you want to share, you have to organize the selected information to fit into a convenient stack structure, and you have to decide how to present the information in a manner that your reader will understand. While your reader might not gain exactly your view of the information, you want to maximize the sharing of your personal perspective. You've worked with the same information again and again. It isn't hard to remember something that you now feel is part of you.

Another shared this remark:

> In creating a stack, you learn the information better. You work to a better level of understanding. It isn't fast but it is fun.

During the first two months of the research study, the student participants in the project spent a great deal of their time browsing stacks on the topics being studied in literature and history class. From the beginning, the browsing sessions were met with enthusiasm and interest. The lab instructor seldom found it necessary to remind students to focus on their work. At the same time, the group was learning about the ACCESS application, gaining computer skills, and developing some understanding of what hypermedia offered as a learning tool. Many questions of a technical nature were asked, and mastering the note taking, book marking, and find feature required teacher assistance.

During the initial browsing activities, students were seldom heard expressing any criticism of what they were reading. One student remarked that it was difficult to decide just where to focus attention during this process. This student felt that having to decide whether to read the text or peruse the graphics and still make useful decisions on which button to use

provided a challenge that didn't allow attention to wander. The researcher confirmed from observations that student behavior during this period indicated total involvement and concentration on the activity.

As students began to learn some of the skills necessary to create their own stacks, their interaction with the resource stacks showed some changes. Students became more efficient at finding the material of personal interest. As one student mentioned:

> I have learned that the 'cues' of buttons, text, sound, and graphic can guide me in two ways. I can make better choices of where to move and I pick up the needed information more quickly. Instead of just looking at the pieces I read them—even if the piece is only an icon or picture. I never realized how much information I was missing.

Students were given considerable assistance by the lab instructor and assistant during the introduction to their browsing assignments in gaining an understanding of how a stack was designed.

Despite the effort to teach the students about the communication inherent in each component, the concept was too abstract for most students to grasp. The concept only gained meaning after the students started learning the skills required to create a stack. During informal conversation with several students in November, the researcher was told:

> I sort of find that I have learned how to use a stack. Instead of just blindly flipping through each card, I can realize where I might find what I want. The ability to use the 'go recent' and 'return' buttons helps me to be faster. Now that I understand the value of buttons and headings on cards containing similar words, I find as I browse I develop a better mental outline of the material. And I don't get confused. Of course, sometimes the stacks are not good. I think I could make them better.

This group of students also pointed out that understanding the basic design principles involved in creating a stack had made them more efficient in navigation. While their first efforts to learn the information was done by just exploring the stack and using whatever buttons caught their eye, their present approach was much more effective. As one student mentioned:

> Now if I use a button and end up on a card that does not seem to relate to what I was expecting, I return to the button and recheck the choice. Before, I tended to feel that I had done something wrong. Now if the action makes no sense, I question the presentation style. Is this where I should be? Do I need to skim the full card to see if

> the key word is actually here? But these distractions are sure annoying. I can see why the design choices are so important.

Most students have become more efficient in their approach to browsing for specific or general information. Browsing assignments are done more quickly and with less need for assistance. Many students also display a more critical attitude towards the resources provided and are less tolerant of the inconveniences created by the author's design choices.

The participants of the research project spent much of the lab time provided using the available hypermedia tools. The comments shared by the group reflect a growing awareness of the unique opportunities provided by these tools. The learning environment provided by ACCESS is complex and students continued to struggle to cope with the load. The technology skills required to be effective learners in the hypermedia environment are developed simultaneously with the factual concepts included in the USC course of studies. The dual challenges inherent to this situation provide direction for what students perceived as positive or negative in hypermedia learning tools.

Category V—Multiple Perspectives and Informal Discussion

The researcher accepted the role of lab assistant to provide the opportunity to gain close access to the research participants. This involvement has provided the opportunity to gather many informal and personal comments from students. One of the areas that continued to promote student discussion was the ability of the hypermedia environment to provide interaction with the concepts from several points of view. The students using the ACCESS hypermedia tools expressed the opinion that learning from hypermedia products helped to develop a greater understanding of the material in part because the material was looked at from several perspectives.

The work in the computer lab setting provided a very different learning environment to what was observed in the literature or history classrooms. Most discussion in the lab was done

on an informal basis and the sound of soft chatter during class sessions was common. The students often worked in collaboration with each other and frequently provided input on each others activities. This exchange of information was done quietly and did not require specific instructor permission. The students were encouraged to maintain their focus on the work, but sharing their expertise was accepted as part of their expected behavior.

The opportunity for informal discussion of issues covered in history or literature provided the students with another opportunity to discuss and express ideas. A typical example of this phenomena was noted by the researcher in October. A group of students were sitting at the table in the computer lab planning their ACCESS/*HyperCard* assignment. The stacks they were to create were to be a visual representation—done as animation—of some concept that they had encountered in the USC course

A number of the group had chosen to look at the situation of the Donner party—the wagon train that was stranded with such devastating results in Donner Pass with the unexpected arrival of harsh winter conditions. The students discussed the options available to the Donner group, the decisions made by the wagon group, the results of the decisions, and what they themselves might have done in a similar situation. The students' conversation moved onward to consider what events, if any, might be met in their present life that would require a similar decision. The historical tragedy presented a dilemma to illustrate the possible conflicts which might arise in their own world. The students made the extension from one setting to the other without direction from any instructors.

In the informal setting of the computer lab, these students freely contributed to this very dynamic discussion. The researcher noted that several of the students adding comments had made very little contribution to the discourse during the formal classroom discussion. The students indicated that they felt more comfortable being part of the discussion where no one person was in the spotlight and everyone was accepted as having something worthwhile to say. This discussion appeared to be an extension of the accepted lab activity of sharing expertise—regardless of the skill involved.

During this spontaneous group discussion, a number of valuable learning opportunities were noted by the researcher. The entire group was looking at some critical issues from a number of perspectives. Each person was learning to express their own thoughts, defend their position, gain an understanding of another's point of view, and adjust their thinking about the issue based on a wide variety of input. All of this learning had occurred spontaneously, with students helping students. In the lab setting, a great deal of this type of learning was observed.

The manner of presenting the material as a hypermedia document illustrated the flexibility available when putting different concepts together. This freedom was reinforced during the informal discussions that occurred in the lab setting. Students expressed an understanding that an individual's personal perspective varies according to the order the information was learned and to the associations placed on the material. The discussions revealed that no two students gained exactly the same concept from the stack regardless of the manner in which they used the stack. And, as one student remarked:

> I realized that I had read these particular cards before. I wondered when that was, so I decided to check. This strand is used from another stack. I was surprised at how different the information sounded when I read it the second time. The context was changed and so I was not paying attention to the same things. I never knew that I could read the same words and get two messages.

As the students become more familiar with stack design, they commented that having options that appeal to each of them seemed to result in several understandings of the same concepts. The stack author tried to provide an optimal or preferred pathway but users change this presentation by making their own choices. Students began to understand that the order material was introduced and the way the material is presented makes a difference in their understanding of the information.

The research participants found the informal lab situation an advantage when learning the complex concepts contained in the stacks. As one student noted:

> I am amazed that when I read something my understanding isn't like someone else's. After several of us talked about what we saw in the stack, I used to wonder if we read the same stack. From the discussion I get a better idea of what was there. I can take pieces that someone else found really interesting or liked and use them to make my

> own knowledge mean more. Something I really liked isn't always noticed by others. So, discussing the information really helps.

One of the direct benefits to students was the noted improvement in the students' ability to express and defend their position. Individuals began to accept that what was read could be perceived differently by each person. The result was that students started to recognize that their own idea might be valid despite the fact no one else totally agreed. With the development of skills needed to explain a concept to others and to then evaluate the opposition and agreement to this idea, students displayed an increased positive self esteem and self confidence. One student proudly announced:

> Based on what I read, here is my opinion. You can agree or disagree with me but unless you can provide good reasons for your comments, I won't change my mind.

The discussions students engaged in as a result of their lab work were often as informative to students as the formal discussions conducted during other class periods.

> You can discuss the information with other people because they have seen and read the same thing.
> Lab is a more social and relaxed atmosphere that helps me in learning. I feel more comfortable about talking here.

The interaction of the entire group created a learning environment that was perceived by students as being safe and supportive.

> Teachers were there to answer any questions. Handouts were easy to read. Other students answered questions and were very helpful.

Since students observed the exchange of information going on at various times, they soon began to feel that this was an accepted and expected behavior. The researcher specifically asked a number of students about the issue of having other students ask for help during the lab session or asking questions themselves. The students indicated that they felt comfortable knowing that regardless of what the problem was, someone would be willing and able to help them. No one would make them feel stupid for asking for help. Sharing what they knew felt good and helped to make the concepts clearer in their own minds.

Category VI—Technology skills

Students involved in this particular research project may or may not represent a typical high school junior level class. The group members had a wide range of computer skill levels. Some students have considerable keyboarding skills while others are still learning to use correct keyboarding techniques. The students with experience in using desktop publishing applications such as *PageMaker 4.2*, find the design aspects of stack creation relatively easy. A few students have had experience with a wide variety of applications and mastered the technical aspects of the ACCESS program faster than most of the group. Regardless of the variations, similar results are expected from each student.

Technology Skills—Keyboarding

The students with competent keyboarding skills appeared to have a distinct advantage in this class. These students found the time required to complete any given assignment was more than adequate and seldom submitted work late. Students with little skill at keyboarding often commented on the difficulty of maintaining the expected time frame. The opinion expressed by the majority of students was that some keyboarding skill is essential to be successful in meeting the demands of this particular program.

Students felt that a self-instructional, self-paced keyboarding program made available for students to use in their own time would be sufficient help to overcome lack of keyboarding skills. Students displayed considerable ability to cope with the problem. Many worked very quickly with the mouse and used keyboard shortcuts whenever possible. The researcher did not find a single student who expressed objections to authoring in ACCESS/*HyperCard*, regardless of their keyboarding skill level. Since much of the content was not text based, many of the components demanded the use of skills other than keyboarding. Many students did

comment that improved keyboarding skills would have made the task of producing the product they visualized easier and faster.

The participants of this research study have recognized that hypermedia learning involves many types of communication. For most of the students, the writing of the text was the most difficult part of any assignment. Hypermedia tools allowed the user to involve pictures and sounds in sharing a concept. This compensated somewhat for weak writing skills and allowed the students to communicate effectively regardless of writing skill. The flexibility of the hypermedia learning environment was appreciated by the students in the research group.

Technology Skills—Graphic Resources

To produce many of the desired components of an interesting stack, students must learn to deal with a number of peripheral devices. The participants in this study placed a high value on using graphics and sound to enhance their presentations. Although clip art was convenient, the limitation of available sources detracted from the value of this method of including graphics. Locating pictures that directly related to their topic choices promoted more careful research and helped them view the material differently.

> As I read the material I'm researching, I try to ask myself if there is a picture that would help me explain the idea better. If I have a picture, I ask myself what information it gives me and would others get the same idea. Then I ask myself if the picture would scan well and fit into my stack.

The constant search for pictures that add meaning to the text helped students to stay actively involved in the reading of the researched information. Many of the students commented on the perceived value of knowing how to use the flat bed scanner and *HyperScan* computer program. The researcher noted that several students made use of these tools for other class projects.

Providing the means for students to include graphics by scanning images also provided the students with an unexpected problem. This research site was the first group to use the

combination of ACCESS and *HyperScan*. A conflict of code between the two computer applications caused *HyperScan* to trigger the protection device built into the ACCESS program. Once the protection device was activated, changes in the stack could not be saved.

Many students, after scanning an image with *HyperScan*, found themselves unable to continue work on their ACCESS stack. Frequently, the image itself was not saved although the image had appeared to be successfully placed on an ACCESS card. The protection device allowed the user to place and see the image on a card but then promptly removed the image when the stack was closed. All students having this difficulty learned that to proceed with the authoring process, they must first check to see if the user level of *HyperCard* had been moved. Level five—the built in scripting level of the program—is needed for authoring. The conflict frequently changed the user level to lower than five.

In addition, students learned to check the stack protection feature found under the file menu. The program conflict often resulted in the protection parameters of 'can't delete-can't modify' to be activated. To correct the problem, the student needed only to deselect these items. However, the deselection needed to be done prior to placing the scanned images into the stack since additions made while the protection was on would not save.

For some students, the automatic pathway feature of ACCESS posed a problem after a conflict with *HyperScan*. In this situation, the name of the student stack—complete with the pathway used by the computer to locate the stack—frequently contained incorrect information or had information deleted. If ACCESS detects some change in the name or pathway to a stack, the special ACCESS authoring tools will not appear. Students learned a method to determine if this error was present and gained the skills needed to correct the problem.

These particular problems appeared to create much greater frustration for the teacher than for the students. The students learned to understand what had happened. Once the steps required to correct the problem were mastered, a sense of satisfaction in dealing with a technical problem on their own was apparent. Many students commented that knowing some problems were not the result of their own mistakes was a relief. Students seemed to be

reassured about their own progress when they realized that even the technology was not perfect. Using their own skills to solve a problem created by the technology appeared to be intensely satisfying to most students.

The problems with software conflicts at first appeared to be a major problem from a teaching perspective. However, the problem solving experience that included immediate teacher guidance when required was perceived as positive by most students. The only negative comments heard from students regarding this particular technical problem was that the time to complete their task was greatly increased. For most students, the gain in understanding of computer hardware and software seemed to far outweigh any disadvantages they perceived.

Students were given the opportunity to use a digital camera. Instruction was provided for any student that expressed the desire to learn. The researcher, as lab assistant, taught the first students expressing an interest to take pictures with a Canon Xap Shot camera and then use *Computer Eyes* hardware/software to place the images into the computer. The images were then moved via the clipboard to the ACCESS stacks using the usual cut and paste routine. Once a number of students were able to use the equipment successfully, they became the instructors for others wanting to learn.

For many students, realizing that a snapshot could be taken and put into a usable form in a relatively short period of time provided a new method of including meaningful graphics in their stacks. Many students used this method to include a picture of themselves on the author card of the stack. The students that included their own picture felt that helping the user have some concept of them as people would enhance the communication. These students commented the stacks they had viewed containing an actual photo of the author made the contents of the stack more real to them. In addition, the picture was felt to influence the way they perceived the information in the stack.

> I like to have a face to connect to the information. I pay more attention to what the words say when I can think of them as being said by a real person.

One student felt that the addition of a personal photograph made authoring and reading the stack seem more like a shared effort. Reader impressions of the author were made based on the picture. This impression appeared to promote a more personal interest in reading since a real person could be visualized as trying to share an idea.

The technical aspects of the digital camera provided an opportunity for students to broaden their knowledge base. The lab instructor and assistant were asked questions related to the technical aspects of the process. A teachable moment emerged that gave an ideal setting for helping the entire group gain a better understanding of the paint tools in *HyperCard*, the different formats a graphic can have in electronic form, and the technical qualities of a graphic that produce a quality image when used in electronic form. From a level of involvement motivated by novelty, a much deeper level of learning activity emerged. The students started with an expressed desire to learn about graphics. The students ended with a better understanding of computer technology.

Images are a natural part of daily communication for these students. The ability to include graphics in the material to help convey information developed rapidly for most of the students. This was particularly true for the students who considered themselves to be visual learners. For several students, the introduction of the graphics techniques proved to be the factor needed to make the hypermedia learning environment one that strongly appealed to them. The effort displayed by these students increased dramatically at this point. Most of the students in this study stated that graphics greatly enhance the effectiveness of communication. The majority of the group perceived that using pictures was a very natural extension of the writing process.

Technology Skills—Sound Resources

Working with sound resources challenged students on a different level. Several students responded to sound resources in the same manner that graphics had fascinated others.

The microphones available with the Macintosh LCII machines in the lab provided an easy method for students to develop skills in creating and using their own sound resources.

The audio help stack provided with *HyperCard, Version 2.0* gives students a tool which allows them to record any selected sound, edit this sound to satisfy their needs, and to place the sound resource directly into their stacks. The class had to take turns using the machines that provided the sound recording features. However, using other computer software, students also learned to move pre-recorded sound resources into the stacks. Once the sound had been placed in the stack, one line of script was needed to have the sound play. Students quickly learned to enter the sentence—play "sound name"—in the appropriate place.

The scripting needed to play sound was the second time the students were required to learn HyperTalk language concepts. Almost all the scripting used in authoring an ACCESS stack is provided by ACCESS. At the request of a few students, the option of learning the scripting needed to have *HyperCard* play a piece of music was provided. In addition to the usual sounds that can be activated from the Macintosh's operating system, a number of sound resources have been placed in ACCESS. ACCESS provides resources such as a saxophone or trombone that provide the opportunity to have relatively musical sound play.

The students were asked to comment on why the addition of sound might be of value in the stacks they had browsed or created. The comments included:

> Sound helps to keep the user involved in the stack.
>
> Audio effects add interest and are fun to learn to use.
>
> Audio gives a different perspective, another way of learning, makes the stack more interesting.
>
> You can hear the person's voice and they might emphasize something you wouldn't have though of.
>
> Can help the user understand the written information or it could be placed in there just for entertainment or direction.

As authors of stacks, the students had made some decisions about the use of sound from the design perspective.

> You can stress the importance of one of your topics in the stack by using music. Also, you can use sound to explain the stack.
>
> Use the sound to tell an important point of your stack and most people are interested enough in sound to try the button.
>
> I think it helps you learn about your topic just in the process of finding sound that is appropriate in your stack.
>
> Depending on what the sound is, you can have more information or a different perspective of the time period.
>
> I can add a bit more information and humor and interest in my stack.

During the research period, students were not given a great deal of instruction on how to integrate sounds, graphics, and textual information. These concepts were dealt with by the researcher after the present study had been concluded. In the ACCESS stacks used for browsing, only the student produced stacks make use of sound. All students commented that a bit of sound would make the other stacks much more fun to read and many students found ways to incorporate sound into their own products.

From observations made by the researcher, sound resources would be a valuable addition to hypermedia products used by this particular age group. The request is frequently made to play music during class. Interest was high when a sound resource was recorded by someone in the class. Stacks from the public domain that contained sound resources were located by the researcher and shared with the students. Every student took the time to browse these two stacks. Each time a student browsed these stacks and played the sounds, the attention of the other students in the room shifted from their own work and they displayed an awareness of the activity of the student viewing the stack.

For the teachers involved, sound quickly became annoying. The obvious distraction the sound created in the class was a problem. In addition, the sounds themselves were acceptable for only a very short time. While the students enjoyed the sound, the teachers perceived the sound as noise. On several occasions, the instructor asked a student to leave the exploration of the sound resource stack and do some other activity. The instructor expressed the view that

sound could enhance communication. However, the instructor did not accept the sample stacks as demonstrating a positive enhancement

Technology Skills—Networked Computers

For most of the participants in the research study, the USC course of studies provided the first opportunity to work with networked computers. Unfortunately, this experience was less than positive. Technical problems frequently resulted in the computer network unexpectedly quitting. Not only did work come to a complete stop but much of the work done prior to the network failure was lost. The speed at which the network could handle the data exchange was far from acceptable. The demands of a full class using ACCESS for either browsing or authoring was impossible for the present arrangement to handle effectively.

The instructor and lab assistant used the technical difficulties as an opportunity to teach the students about the electronic processes involved. Information on types of networks, choices of hardware and software, conflicts between software, the need to back-up data files, and other technical knowledge was shared. Students were given hints on how they might avoid certain problems and a number of strategies were developed to help students overcome the limitations of the network. Having only a few students save at a time and asking students to save frequently did provide some relief. Using *HyperCard* from either a hard drive or a floppy disk reduced the load on the server. Although the loss of work was extremely discouraging, most students handled the technical limitations with more patience than the teachers involved.

Technology Skills—Note Taking

One of the major problems involved the note taking feature of ACCESS. Students were taught to use the on-line note taking feature when doing their browsing assignments. The note taking feature is a word processing window that can be used from any card in the program.

The word processing features available for use in this environment are minimal. While the usual cut and paste routines are available to students, the note taking feature has no spell checking ability. When the tab key is used, instead of indenting the text, the text becomes totally highlighted and was often accidentally deleted as a result.

Entries made in the notes window must be typed by the student. The students cannot use the Macintosh copy and paste ability to select text from an ACCESS card to paste into the note window. All ACCESS stacks are protected and each text field within the stack is locked. With the fields locked, the contents cannot be changed in any way or selected for copying. This prevents the student accidentally or purposely changing the content during the browsing process.

From a teaching perspective, the protection of the stack is very helpful. Since the student cannot copy and paste, they are forced to compose their own note entries. The students cannot merely copy words without processing their content. The need to read and decide on what information is worthy of noting helps to keep the students actively involved in their learning.

The notes made by the students can be printed directly from inside ACCESS and can be saved for later use. If a student wanted to format the notes into a nicely presented document, the easiest approach was to open and edit the file in *Microsoft Word, Version 4.0* . ACCESS prompts the student to save the notes as they exit from the ACCESS application. However, the saving operation did not always work correctly. If the network failed while the notes were still open, the work was usually lost. As one student expressed the frustration:

> Is there anyway to get this machine to stop eating my notes? It has had a steady diet of my work over the last week!

One example of coping with technical limitations was the approach developed for saving notes. Sometimes a workstation is forced from the network by an error that occurs on another computer or in the server itself. If an individual workstation had been disconnected from the server as a result, the notes were often still available in the memory of the

workstation computer. However, the usual saving options within the ACCESS program were no longer available since the needed electronic connections had been lost. In this situation, the student could create a one-card stack with a scrolling field. Using a copy and paste routine, the notes could be safely placed in the field.

Another option was to copy the notes from the open ACCESS stack and store them in the scrapbook—a storage area available on machines having this desk accessory installed—to be moved into *Microsoft Word, Version 4.0* for editing. While learning to use these techniques increased the problem solving skills of the group, this did not compensate for the frustration of having so much time and effort wasted.

Notes that are created and saved in the manner intended by the design of ACCESS, can be reopened and continued during the next browsing session. Notes that have been saved by one of the preceding techniques are no longer in the correct form to allow ACCESS to open them. If the student wants to use the notes for any purpose, they must use another application to open the file.

While the technical limitations provided a great deal of frustration to the teaching staff, the evidence presented by students suggests their perspective is different. The questionnaire completed in January allowed an opportunity for students to comment on their experiences with the note taking feature of ACCESS. The negative comments do not include a description of the network problems but instead focus on limitations of the ACCESS program itself (see figure 16).

> The notes window gets in the way and blocks the view of the card.
>
> When the notes are made smaller, you can't refer to what you did earlier.
>
> I don't know why you can't resize the notes to an in-between size. I would like it to include at least the last 7 lines I've typed.
>
> I often delete all the text with the tab button which I think is going to indent the text. Instead it all disappears.
>
> There are no special features available like bolding or underlining.
>
> Your notes are always in the way.

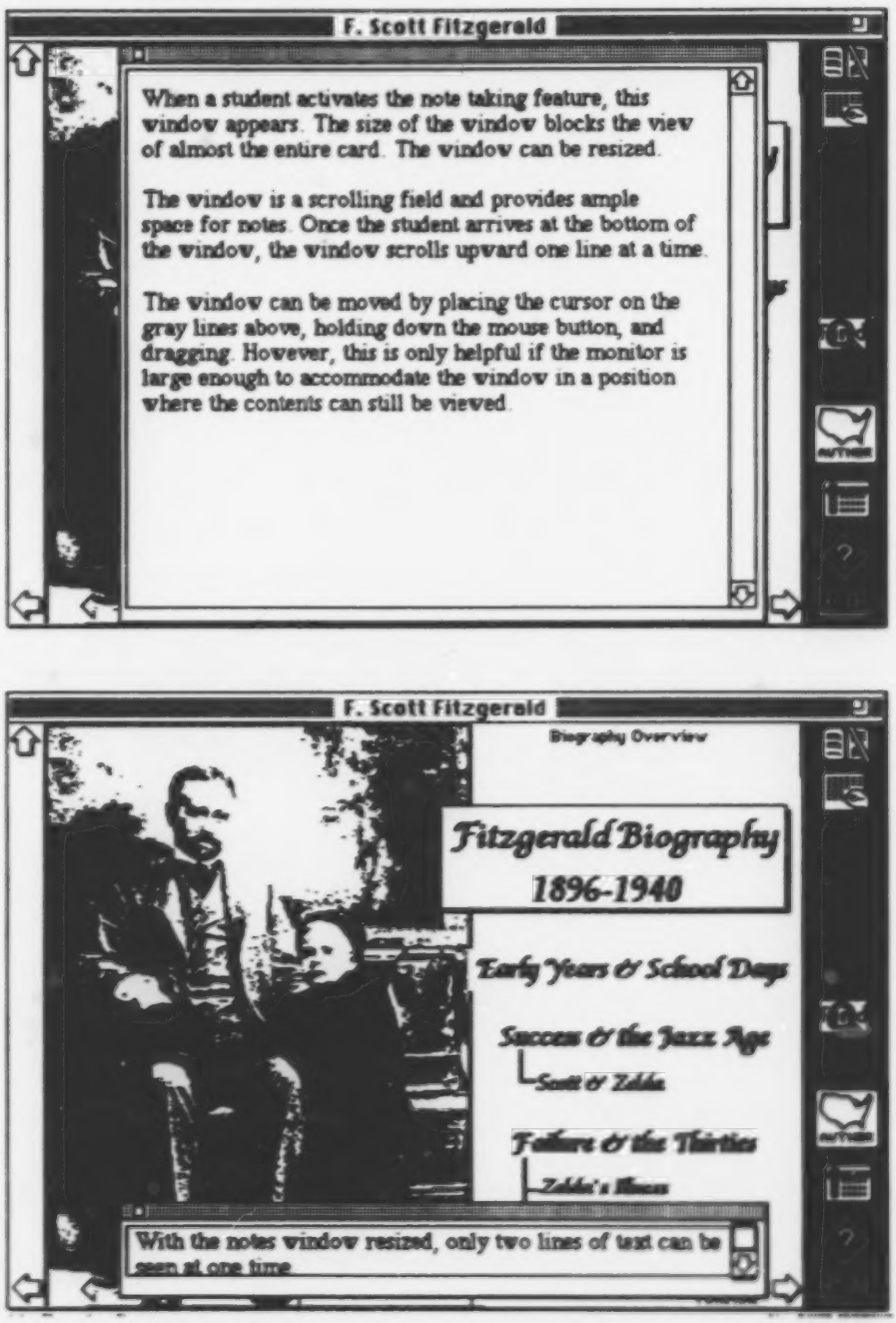

F. Scott Fitzgerald
When a student activates the note taking feature, this window appears. The size of the window blocks the view of almost the entire card. The window can be resized.
The window is a scrolling field and provides ample space for notes. Once the student arrives at the bottom of the window, the window scrolls upward one line at a time.
The window can be moved by placing the cursor on the gray lines above, holding down the mouse button, and dragging. However, this is only helpful if the monitor is large enough to accommodate the window in a position where the contents can still be viewed.
F. Scott Fitzgerald
Biography Overview
Fitzgerald Biography
1896-1940
Early Years & School Days
Success & the Jazz Age
Scott & Zelda
Failure & the Thirties
Zelda's Illness
With the notes window resized, only two lines of text can be seen at one time.

Figure 16: Note taking window in ACCESS.

> The machine gets behind on the typing so you have to wait or you can't tell if you've made an error. There is no spell checker to make corrections for you.

The problems that annoyed students are less critical than the system failures resulting from network limitations. However, the problems that do occur are constant. In order to include the note taking feature, certain limitations had to be accepted by the designers of ACCESS. While students do indicate their displeasure with the restrictions, the ability to take notes on-line has been appreciated.

Students have as many reasons for liking the note taking feature as they do for disliking the feature. On the positive side comments included:

> There is no limit to the amount of notes that you can take.
>
> By writing something down it helps in the remember process.
>
> Using the notes makes it quicker to edit, print, and write notes. The notes can be printed for easy reference when working away from the computer.
>
> Taking notes is increasing my typing skills.
>
> Notes helps me to pick out useful information and make a decision if I have all of the information that I need.

Technology Skills—Value for Employment

Students were very open about admitting that one of the reasons they selected the option of the USC course of studies was to increase their computer skills. Students view these skills as valuable to their own future regardless of their career decisions. The majority of this group of students felt very strongly that technology will play a key role in their lives. Developing competency with technology as students was viewed as an advantage to their chances of employment.

> Computers will be taking over in the year 2000 and if you want a good job you will have to know how to use them.
>
> I think in the modern world computer literacy is of vital importance.

> I feel that computers are going to be used more and more in my future and I need to learn to use them well. I also feel that it is neat to work with computers.
>
> I have a lot of experience with an IBM but wanted to expand my knowledge to Mac's.
>
> Computers are a more interesting way to do your work and I feel it will be helpful to know how to use them in the future.

Students viewed the hypermedia and technology component of the USC course of studies as an opportunity to learn in a unique and enjoyable way. A similar section of the course is offered in the afternoon. While both sections use the interdisciplinary approach to the curriculum, the afternoon section does not include the use of hypermedia or contain a computer component. For many students in the research group, the computer component was the deciding factor when making the decision of which section to take. The most frequent reasons expressed for selecting the morning USC course of studies were:

> I like to use computers.
>
> I want to know more about computers.
>
> Computers are a great way to learn something.

Other student comments included:

> To be honest, I didn't know there was another section—but I like the computers.
>
> This section offers more credit, computers are in the future, why settle for less than the best?
>
> I am here simply because of the computers.
>
> I'm going to need to know something about computers for in college and life in general.

The need and desire to understand technology has been a major focus for the students in the research group. The students showed an growing awareness of the increased role of technology in their society. Students perceived the hypermedia component of the USC course of studies as one of only a few programs at this high school that provides the opportunity to develop technology skills. The perception students developed of the value of hypermedia learning environment was influenced by their acceptance of technology as an undeniable factor in today's world.

CHAPTER V

IMPLICATIONS FROM THE RESEARCH STUDY

In this chapter of the dissertation, the research questions are reviewed and answered. The implications that result from this study are presented. The limitations found in the present study are presented and discussed. A number of suggestions are given for further research based on what has been learned from the present study.

This research was based on a specific set of questions that directed the observations and attention of the researcher during the entire study. Each phase of the study has been guided by the desire to obtain the information required to answer these questions. The following questions were asked.

1. What are the students' perceptions of their learning within the hypermedia environment provided by using ACCESS/*HyperCard* in the United States Culture program?
   - What are some of the more difficult aspects of hypermedia as perceived by students?
   - What are some of the factors that students perceive as an advantage if the information is given in hypermedia format instead of print information?
   - What methods do students perceive as effective in determining that they have completed the task of learning the material in a hypermedia format?
   - What do students perceive as advantages to producing their own work as an ACCESS/*HyperCard* stack rather than as a traditional print product?
   - What do students perceive as needed personal skills and technical equipment to function productively and efficiently in the hypermedia environment?

2. What do students acquire in the hypermedia environment in terms of recognizing the relationships and associations inherent in the material presented?

The data presented in the preceding chapter provides the information needed to formulate tentative answers to these questions.

Discussion of Question 1

The students in the USC course of studies were introduced to the ACCESS hypermedia environment in September. The present study investigated the program from early September until the end of January. During that time, the participants of the research project spent a great deal of their class time working with ACCESS to complete a wide variety of assignments. ACCESS was used for browsing prepared stacks and for authoring new stacks. The perceptions of the students have been shared directly in the preceding chapter of the paper.

Question 1a

- What are some of the more difficult aspects of hypermedia as perceived by students?

Difficulty with Hypermedia in General

The research literature suggested that students would perceive getting lost in hyperspace a problem. However, the students did not perceive being lost in a stack in a structural or location sense as a problem. A number of coping strategies dealt with this phenomena satisfactorily. However, students perceived the mental distraction resulting from the disorientation as a problem. Breaking the train of thought whether for navigational reasons or technical problems such as slowness of action on the network, was perceived as an added burden in the learning process.

Students perceived the time demands of hypermedia learning as a problem. Many students expressed the opinion that producing a hypermedia product required considerably more time than a comparable traditional written assignment. The necessity of being in the lab in order to work with the hypermedia document meant that time outside class could be used only if the student planned ahead. Since the lab facility was frequently used for other classes

after school, extra computer time was limited. In addition, if the student encountered difficulties while working on their own, solving the problems had to wait until the next class.

The learning environment created by hypermedia tools is complex. The students indicated feeling considerable pressure from this complexity. Students needed to constantly be open to learning on two levels. Simultaneously learning the hypermedia interface and the quantity of new material presented in the stacks was difficult. For some students, the cognitive challenge created by this dual agenda was sufficient to make the work load considered difficult. The enjoyment the technology brought to the learning situation did not totally compensate for the complexity of the learning situation.

Difficulties Specific to the Research Site

Once the novelty of the hypermedia presentation had faded and the personal authoring skills of each student developed, legitimate criticism of the quality of the material was expressed. During the first two months of the study, the students seldom expressed any criticism of the resource stacks. When their understanding of the communication process inherent in hypermedia increased, many students commented that more pictures, a bit of sound, and shorter chunks of text would make the stacks more interesting and easier to read. The ACCESS resource stacks, while providing some valuable information, could be improved to increase the effectiveness and enjoyment in the learning process.

The technology used in the research site has also influenced the perceptions of the students. Some students have been frustrated by the slowness of the network environment and the unreliable service provided. Hypermedia is an electronic based presentation tool that demands the user work within limited parameters. Some of the students viewed this electronic presentation as providing less than a desired means of learning. Some of the technical problems could have been avoided with better planning of the lab organization and more

constant maintenance of the hardware and software being used. However, problems of a technical nature appear to be a reality in a hypermedia learning situation.

Question 1b

- What are some of the factors that students perceive as an advantage if the information is given in hypermedia format instead of print information?

Value of ACCESS Stacks Authored by Teachers

The students in this study have indicated that the advantages of hypermedia presentations over traditional print formats are numerous. One advantage perceived was the actual writing style used in the stack presentation. The concise, abbreviated approach taken to make best use of the limited screen presentation appealed to the students. The students felt that having the electronic links make the connections between pieces of information made understanding the material easier. The links removed the need for much of the transitional writing that is encountered in book formats. The students felt this allowed the writing to express what was important without making the reader also read a great deal of material included just to make the material fit together.

The advantages of hypermedia's ability to include multiple forms of information was noted. For most students this factor was viewed as exceptionally helpful. Students felt that the hypermedia tools met individual needs and allowed students with different learning styles to function effectively. In traditional classroom approaches, the students indicated feeling more pressured to approach the learning in a single manner dictated by the instructor.

Perceived Advantages in Hypermedia Writing

The students perceived the challenge of providing written information in the ACCESS environment as an advantage. By thinking of each piece of information as a small, relatively independent block of text, the students said that composing the text was made easier. The task was not perceived as having to produce ten pages of text, although in many cases students actually did write that amount. Instead, students said they wrote in terms of complete ideas. Ideas that depended on each other to share the total concept that wasn't constructed unless all the pieces were read. At the same time, each idea needed to be able to stand by itself. If a user read only the strand containing that idea, the students wanted the user to learn at least that one idea. As one student remarked:

> When I write a paper I never seem to have enough words to say. Here, because I think I'm saying less, I never have enough space to say everything I'd like to. Part of that is because I try harder. But partly I just see the information differently.

Once the student had conveyed the idea, the electronic link provided the connection with another concept and the traditional transitional writing was not needed. This eliminated a part of the writing process that students perceive as particularly difficult.

The chunking that resulted from organizing the material into strands has helped the students cope with new concepts. The actual physical modeling of the associations inherent to the topics was also perceived as valuable in the process of creating the completeness of the concepts being studied. One of the students made a comment about the lack of ordering needed to place text in a hypermedia document.

> It isn't that the order is gone. It is just that I don't have to make the final decisions about it. Knowing that the information will still provide a concept if someone reads the order differently than I would, has made me realize that concepts are not rigid.

Most students were unaware that a written document could be given in more than one order and still make sense. This may be partly the result of numerous instances where their writing was graded by a teacher that suggested certain paragraphs needed to be rearranged. Sometimes elements do need to be given in a specific order. As one student said:

> I'm beginning to understand that there is an 'importance' to consider. And some information comes before another. And some pieces are equally important and could be changed. Writing a paper never showed me that.

Several students have remarked on the ease with which they could use the same concept for another purpose. Placing a link that included material from someone else's stack to help make their own concept more complete has helped to illustrate some key concepts. Context of the information was critical to the meaning of the information. Several points of view could be valid at any time and depended on the use being made of the information. Every student was required to find two links with other stacks to place in the stack created for their term project. Most of the students indicated that they could find more than two such associations.

Another valuable aid to writing hypermedia documents in the view of the students, was the fact that the idea didn't have to be explained with text alone. For the students that felt their writing skills were weak, the ability to use a graphic to help explain the ideas removed some of the pressure of the writing. As one student remarked:

> I know my writing isn't the best. But, I visualize information easily. I know that by including a picture I can tell the reader what I want to say.

For the students, writing quickly became a combined effort with words and pictures. In many cases, students felt that with one picture they had conveyed more information than had they filled the screen with text.

The students using graphics to support their writing, perceived another element to the writing process that was new. The need for the user to connect the graphic and text was recognized. In most cases, by learning to provide a short, concise caption on the picture, students were able to eliminate the need for considerable writing. For some students, the integration of the two medium was only just beginning to be understood by the end of the study.

Although sound was included by some students, this resource was used less than images. Most of the instruction on sound was included in the program after the research had

been completed. The students found sound maintained an interest and, when combined with a graphic, produced an added emphasis to some point that they were unable to achieve with written words.

Using hypermedia tools, the students were encouraged and assisted to be much more flexible in finding ways to share ideas. Using sound, graphics, and text in an integrated presentation format made them feel what they wished to say could be heard more easily by others. A large number of the students in this group indicated they felt remembering the concepts was done easier and faster as a result of the multiple presentation methods.

Empowerment of Hypermedia

Students felt that a major advantage in using a hypermedia learning environment is the power provided to them as individuals. The effort required to produce a stack that included text, graphics, and sound allowed them to develop an expertise in this topic. In addition, the increase in computer skills provided an opportunity to feel a positive recognition from others. Students were called on to share the skills they had developed. In many cases, their knowledge level exceeded that of the classroom instructor. The positive self esteem that resulted from the feedback—both direct and indirect—the students received from the sharing of their skills provided an incentive to further increase their efforts. Teaching a concept to others provided a powerful way to encourage the student to understand the concept in depth.

For students, a major advantage to using hypermedia to create their own presentation was the ease of sharing their work with others. Written assignments were perceived as something done only to satisfy the demands of the teacher. Once the paper was written and submitted, the teacher read the work, returned the paper, and the paper was totally ignored from that point forward. With the hypermedia product as the assignment, the product was shared with other members of the class and often with family members or friends. Students

perceived their work as contributing to the knowledge base of someone else, not simply an exercise for their own learning process.

Question 1c

- What methods do students perceive as effective in determining that they have completed the task of learning the material in a hypermedia format?

The hypermedia documents used in this study were not particularly large. The largest resource stack used has only 289 cards and requires only 903 K of storage space. When specifically questioned, the students did not indicate they had any method to decide if all 289 cards had been read. The students did not concern themselves with the concept of completing the task of reading a hypermedia product. The perception of the students involved the measurement of assignment completed rather than hypermedia document read. Students felt that if they have managed to obtain the information needed to complete the given work or to understand the issues being studied, knowing if they had read every screen was unimportant.

With hypermedia documents of this size, the students may in fact be getting a sense of completeness in two quite distinct ways. When available, the map card may be providing the knowledge that the task is done. Many students did establish a concept of having seen the complete stack by comparing the map card to the mental picture they had created of the stack. The researcher observed other students skimming the stack one final time to quickly recheck the contents. These activities may have provided a sense of completeness to the task.

Question 1d

- What do students perceive as advantages to producing their own work as an ACCESS/*HyperCard* stack rather than as a traditional print product?

Students perceived the authoring of hypermedia products in a very favorable manner. The opportunity to use sound, graphics, and text to convey their ideas was viewed as very

powerful in communicating ideas to others. In addition, a hypermedia product provided the opportunity to be creative and allowed greater freedom of choice to the author than did a traditional print product.

The students perceived many similarities in the task of writing an essay and producing a stack on the same topic. Part of this may develop from the teachers approach to the term research project. Producing the text content of the stack as a word processed document may have increased this feeling for students. Regardless of format, researching and learning the subject were necessary. However, students indicated that because of the different way they perceived the hypermedia product being used, the tasks were distinct. A traditional paper does not allow much flexibility and the linear format requires decisions about the order of presentation that students find difficult to make. With the freedom of nonlinear presentation, students could more easily decide which pieces of information were equally important and presented them at the same level. The user decided the final arrangement of the information by the choices made while reading the document.

Writing a traditional paper assignment is perceived by students as a lesser challenge than writing a hypermedia document. Less care was taken when selecting information for a paper than for a hypermedia document. Organizing the information for a paper based presentation was done with less concern for the quality of final outcome than with a stack presentation. Since the paper was shared only with the teacher, the writer took less care with the organizational details. Teachers' expertise was expected to offset any limitations created by an author's poor choices. The students perceived their hypermedia product as something that would be shared by a much wider audience. The students tried to decide what information was needed to convey the ideas to people with different background knowledge on the subject. Then, since the order the information is read can be only partly determined by the author, the students made a greater effort to present the ideas in a way that would help the user understand the total concept.

For the students in this study, the chance to present their work in hypermedia format added a sense of enjoyment and fun to the task. As one student remarked "I'm never totally sure what I have until the entire stack is completed. That makes it exciting." This perception was not mentioned in regard to traditional written work. Reflecting about feelings towards producing written assignments, another student said "I get bored with writing something only the teacher reads. It is marked and forgotten. It has little value." The students in this study perceived a value in their own products beyond completing the requirements of the course. If others could gain from the work they had done, then making the effort to produce useful work was worthwhile.

The students frequently expressed a comparison of what was learned by writing a paper versus what they learned by producing an ACCESS stack. They perceived that material researched for the stack was learned at a much deeper level. To produce a stack, the student needed to interact with the information from a number of perspectives. The student concentrated on the information a number of times. The student researched the topic and decided on the information to include. The student made the decisions needed to write the material in a way that would maximize communication with others. The student considered what information the user of the stack needed to understand the topic, keeping in mind that a user could have less background knowledge than the student author on the particular subject.

Once the textual content was selected, the information was dealt with from another perspective. The author decided on graphics and sound to support and enhance the communication process between author and user. The information in the graphic and audio additions needed to integrate with the textual information. Finally, for each card the author selected the specific content and design. Each of these steps forced the learner to actively use the information in a slightly different way. The students in the research study identified this as a major advantage in learning the concepts.

The manner in which the task was approached by students may also be contributing to the perceptions they developed about hypermedia. The instructors in the USC program have

made instructional decisions for the present program based on their experiences of last year. Teachers identified two major problems in relation to work done by students last year on a similar assignment. For the major stack assignment of last year, the students created all the textual content directly in ACCESS. ACCESS does not provide any spell checking feature and the number of spelling errors in the text detracted from the value of the information. Also, many students failed to place sufficient textual content in their stack to communicate the ideas effectively. The informational content of many stacks was minimal and of poor writing quality. Teachers realized the extent of this problem much too late to correct it last year.

The instructional approach taken during the research study was designed to prevent these same errors from occurring. Producing the text content in *Microsoft Word, Version 4.0* had the advantage of providing access to a spell checker. This advantage was offset by the extra time needed to get the appropriate text placed on each card. Asking that students do the writing first assumes that students want to interact with the ideas first in verbal form. They are restricted from starting the authoring process with visual images or mental sounds. In addition, the first presentation of the textual content is linear. Although the material for each strand is introduced by a heading rather than transitional writing, the students do view the information from a more rigid perspective than can be accommodated in a stack. Efforts to solve one set of problems may be inadvertently creating a situation where hypermedia learning is not being used to its full potential.

Question 1e

- What do students perceive as needed personal skills and technical equipment to function productively and efficiently in the hypermedia environment?

Students have expressed a number of opinions on what skills would be considered essential in making effective use of hypermedia learning environments. The most significant concern expressed by students was the issue of keyboarding skills. The more competent the

student was with the keybcard, the less difficulty they encountered in meeting the demands of the hypermedia environment. Several students expressed the opinion that as their understanding of how a computer and the computer network functioned from a technical aspect, the easier they found learning with hypermedia tools. One student commented that once he reached the level of competence at the computer where he was no longer constantly aware he was using a computer, learning the material seemed easier to accomplish.

Hypermedia learning environments have the potential for a rich, varied presentation of information. The participants in this study expressed appreciation of the skills they had gained in using such peripheral devices as the scanner, digital camera, microphones, and printers. They value these skills from two points of view. First, these skills are considered useful to assist them in securing jobs. Students felt that potential employers appreciated seeing a list of specific skills on a resume. Secondly, students gained a number of problem solving skills and additional skills in knowing how to meet the challenge of learning something new. The students placed considerable value on being able to develop a wide range of skills that could be used to maintain employment. Since students accept technology as an integral part of their world, they perceive technology skills to be of particular value.

The use of peripheral devices that are part of the hypermedia learning environment broaden the students communication ability. The hypermedia environment has provided an opportunity to gain a greater awareness of the role sound, color, pictures, movement, and general appearance play in communicating ideas. Many students expressed the recognition that when they write a paper they now realize that how the information is presented also carries information to the reader. Teachers indicated that the students' writing skills had noticeably improved during the research study. As one student remarked "I never paid much attention to each word before. Just tried to think about the idea. But every word says something."

As the students began to demonstrate an improved skill in sharing their ideas via hypermedia, they also demonstrated an improved skill as a consumer of information. The research group shared their perception of the hypermedia environment as encouraging a more

natural communication. Hypermedia provided a flexibility found in conversation and everyday communication. The communication process in a hypermedia environment was not limited to written words. A context could be created to help the words have meaning. As the students became more aware of the integration of the media used during communication, the students became more effective at making use of the options. Several students felt that they viewed television and newspaper presentations differently since gaining the skills needed to use hypermedia learning tools.

Discussion of Question 2

2. What do students acquire in the hypermedia environment in terms of recognizing the relationships and associations inherent in the material presented?

In the literature review considerable attention was given to the idea that hypermedia products provided a natural method of communication. Vannevar Bush viewed hypermedia documents as an application of the way in which the mind actually handles information. Learning from hypermedia documents should give students an advantage in understanding the complex relationships that exist in the material covered in the literature and history classes. Accepting the idea that information does not exist in isolation provides the basis for the interdisciplinary design of the USC course of studies. If a hypermedia learning environment does allow students to increase their ability to establish and remember the relationships, some evidence of this should be available.

The researcher focused considerable effort on observing changes in the manner in which students perceived the relationships in the information and material learned. Hypermedia presentations model the associations perceived as important to the person designing the stack. The button links are a concrete and visible indication that material at each end of the link is associated in some manner. The linking feature within ACCESS hypermedia documents allows different users to establish links to the same material. The reasons for the

links may be totally different. When the context in which the information is used was changed, the message in the information could be perceived in a differently.

A frequent task given to the members of the research group was to find other ACCESS stacks that would link to the information contained in their own stacks. At the beginning of the research study, the task of establishing links between stacks gave students considerable difficulty. During the last browsing assignment, students showed clearly that this job was no longer difficult. Not only could students now justify a link between chunks of information, but they were also competent at explaining the absence of a link.

The awareness that information was associated has increased greatly during the observation period. The USC course of studies is an integrated presentation of literature and history concepts. It is possible that students would be gaining similar skills in seeing the connections in the material without a hypermedia learning environment. However, the participants in the study did find having the associations physically modeled helpful. The association of ideas was made clear to them. As they worked with the resource stacks, the buttons served as a reminder to them to consider why the chunks of material were connected. The hypermedia format helped to make a difficult concept less abstract and increased the students' awareness that pieces of information don't exist as isolated entities.

For each linking button that students created in an ACCESS stack, a special field annotation field was automatically created. This annotation field provided the student a place to explain their reasons for placing the link. When the entry was completed, the annotation field was hidden from view by either clicking in the field's close box or holding down the command key and clicking on the associated button. When a user of the stack wanted to read the annotation, the command key was held down when the button was clicked. This made the field reappear.

To complete the annotation field, the author was forced to verbalize the association they perceived. Being able to put into words a connection that is perceived in your mind is not

easy. Early in the study, the annotation fields were often left empty or were ineffective in sharing the relationship the author had identified.

Examining the contents of the annotation fields was a time consuming but interesting element in reading a student's stack. At the beginning of the study, the types of annotations that were found were not particularly helpful. In many cases the content simply restated what the reader had already learned from reading the button name. A reason for the link's creation was often obvious to the reader. However, since the purpose of the annotation was for the author to provide their personal interpretation of the association, the intention of the annotation field was not necessarily being met.

By the end of the study, most students showed a tremendous improvement in being able to articulate the associations they were making. This does not necessarily support a conclusion that students were making more and better associations. It does, however, show that students were learning to verbalize and share the connections their insights provided. Being able to verbalize a concept is an indication of the extent to which the concept has been learned. The improvement in the annotation field entries does suggest that the student understand the relationships in the ideas.

The participants in the study have been using concept mapping as a communication tool during the entire study. The literature and history teachers spent considerable time in September and October teaching the students how to produce a concept map. In addition to class assignments that required the creation of a concept map, the students were often asked to make one during an exam or quiz. During the research study, the quality of the concept maps improved considerably. The number of items that appear, the number of lateral connections, and the complexity of the structure have all increased (see figures 17 and 18).

The information conveyed with a concept map is similar to the information contained in the map card of the ACCESS stacks students create. Many of the students commented on this similarity and felt that their expertise in stack construction was increasing their ability to visualize and construct a concept map. The two examples shown in figures 17 and 18 provide

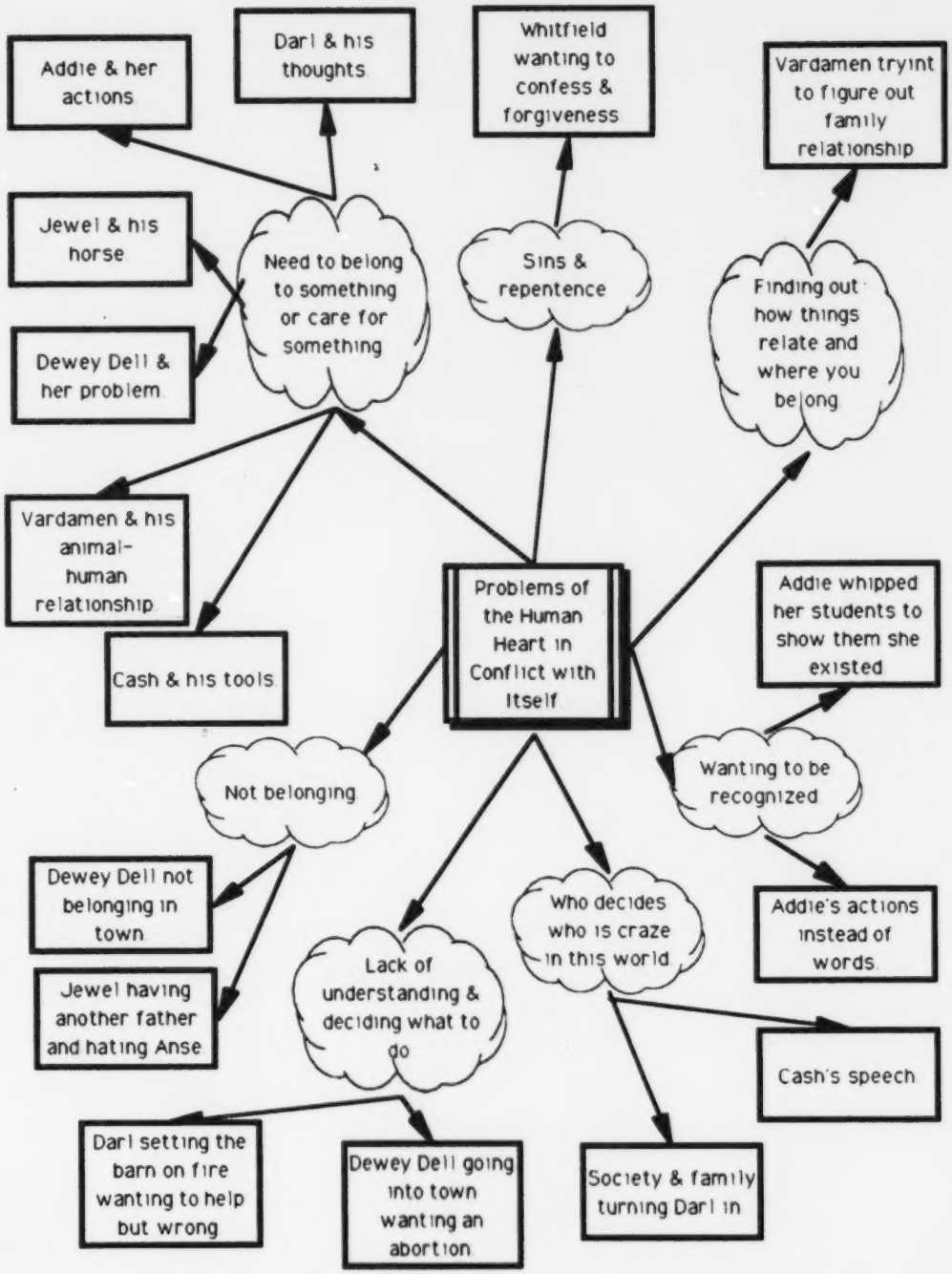

Addie & her actions
Darl & his thoughts
Whitfield wanting to confess & forgiveness
Vardamen tryint to figure out family relationship
Jewel & his horse
Need to belong to something or care for something
Sins & repentence
Finding out how things relate and where you belong
Dewey Dell & her problem
Vardamen & his animal-human relationship
Cash & his tools
Problems of the Human Heart in Conflict with Itself
Addie whipped her students to show them she existed
Not belonging
Wanting to be recognized
Dewey Dell not belonging in town
Who decides who is craze in this world
Addie's actions instead of words
Jewel having another father and hating Anse
Lack of understanding & deciding what to do
Cash's speech
Darl setting the barn on fire wanting to help but wrong
Dewey Dell going into town wanting an abortion
Society & family turning Darl in

Figure 17: Student concept map.

Love hate relationship with horse.
Love hate relationship with Mom.
Can she get an abortion at the drug store?
Mother's death.
Gives up horse for new team for wagon.
Jewel
Should she get an abortion?
Beats Jewel the most; Loves him the most.
Dewey Dell
His will to tell Anse the truth same as action - hal
Deceiving family about Jewel
Problems of the Human Heart in Conflict with Itself
Addie
Affair with Whitfield
Whitfield
Darl
Wants to know if his Mom is is-was
Vardaman
Affair with Addie
Preacher
Wants to know if he is
Confused
Is his mom a fish or a horse?
Family turns him in
Loves Mom wants her buried
Death
People think he is crazy
Tries to burn the barn down.
Keeping the buzzards away.
His Mom needs to breath; drills holes

Figure 18: Student concept map.

BEST COPY AVAILABLE

the reader with examples of the students' work. These examples show the complexity of the concepts as understood by the two students. The associations are illustrated with directional arrows and several items are connected to more than one item in the map. The concept maps included also illustrate the flexibility used by students to complete the given assignment. Both maps were graded by the teacher as being excellent work yet the two products are very different in content and approach.

Additional Questions Which Emerged During the Study

Questions emerged from the study which had not been anticipated by the researcher. To make use of the information which emerged during the study, further questions have been added to the discussion. The researcher provides this discussion in response to the phenomena actually observed in the research site. This prevents the study from being limited to the predetermined issues of interest.

- Will a hypermedia environment produce changes in the behavior of students helping each other to learn?

Much of the learning observed in the hypermedia learning environment was the result of students helping students. The relaxed approach to learning promoted by the hypermedia tools resulted in considerable spontaneous group learning situations.
Collaborative learning was observed between student groups that formed simply because of the seating arrangement in the computer lab. Other cooperative groups formed based on a common interest. Other groups formed simply because someone observed a problem that needed to be solved and required the expertise of another class member.

The concept of cooperation rather than competition is perceived as valuable to the way students perceive their own learning. During a discussion with a parent of one of the students, the researcher was informed that from a parent perspective, one of the greatest contributions the USC program had made to his daughter's education was to remove the pressure of

competition. This particular student has always worked to excel in every thing she attempts. She had begun to view success as achieving a better grade than anyone else did on the same task. This pressure had created a number of emotional outbursts caused by the tension of trying to maintain this excellence.

The researcher was told that this student was beginning to develop other measures of success and no longer evaluated herself on a numerical scale that compared her rating to others. The parent observed a much healthier approach to her effort to succeed. She was beginning to realize that there are many ways to perceive success and some had greater value than others. The cooperative atmosphere that emerged in the hypermedia based learning situations has fostered a much more comfortable situation for this student. With the implied pressure of competition no longer a constant problem, this student appears to be both happier and healthier according to what her parents can observe.

The cooperative attitude of students developed in part from their reaction to the perception that hypermedia documents were of public value. When a student authored a stack with the intention of sharing the stack with others, the competitive nature of learning was no longer maintained. The students created a stack that they hoped would be used to help another person learn the information they had learned and presented in the stack. Students saw themselves as teaching each other about the things that really interested them. The sharing promoted a feeling of comfort and acceptance that removes unnecessary pressure for students to be best.

- What do students perceive as needed skills the instructor must have to maximize their learning opportunity?

The complexity of the learning environment provided by hypermedia tools demands a great deal of effort from both teachers and students. In the present study, the students felt their instructors needed considerable technical expertise to help them learn. The computer technology provides an opportunity for students to develop problem solving skills. The more

options a teacher could demonstrate and successively assist students to learn, the more successfully students felt they would be in learning ways to problem solve.

The technical difficulties encountered in the Macintosh lab represented an area where further teacher training would have benefited the entire group. Some of the problems were created by software conflicts. This is an area of expertise that few people have mastered. Yet, this information could have increased the production level of all students working with hypermedia. Keeping the technical problems to a minimum needs a greater technical background than is available in the combined resources of the staff involved with the program.

Teachers need to have a competence in a wide range of communication skills. Students felt that instruction on communication with integrated media was limited. Their own understanding could have developed further had teachers had the needed knowledge. The three teachers involved in the USC program were trained in traditional education programs and have not received instruction in the communication processes used in this situation. Certainly, greater background knowledge in this area would have been welcomed by all members of the group.

Students were exhibiting a hypermedia approach to learning in another sense. When they started to learn a new skill, the questions they asked tended to veer the instruction into totally unplanned topics. For example, the instruction that began as an effort to help students place a snapshot of themselves into a stack grew into a presentation of several important concepts in using electronic documents. Understanding graphic formats is helpful in making decisions that optimize the quality of included graphics. Understanding software and hardware interaction can help to increase the concentration used when working with the computer. Once students understood the reasons for some of the problems that occurred, they also understood the steps needed to prevent the problem.

One of the problems encountered by students was the difficulty of saving files. They were to maintain a back-up copy of their files on a data disk. Many students carried the floppy in their backpacks or simply tossed them onto the seat of their car. As a result, many files

could not be accessed since the disk was too damaged for the computer to read. Students were instructed on how data was stored on a floppy disk and how the data was read. A number of disks were dismantled so students would know exactly how fragile the disk actually is. After this instruction, a number of students indicated they had purchased a carrying case for their data disk to protect the disk from damage. The number of disks that became stuck in disk drives dropped significantly after this instruction. However, the information can't be shared if the instructor doesn't have the knowledge.

Summary of Research Study and Researcher Recommendations

For the remainder of this dissertation, I will write in the first person. The focus of the paper is on my opinions—opinions developed through being immersed in the study. In the five months of the research study, I spent a great deal of time at the research site observing both students and teachers. I chose to focus on determining the perceptions the students developed about learning in a hypermedia environment. Each of the research questions has been answered in detail in the previous pages. I have determined that while students perceived both advantages and disadvantages to working in a hypermedia learning environment, on average they deemed the overall experience worthwhile. Further, the participants indicated a willingness and desire to continue learning in this manner.

Complexity of Hypermedia

As I consider the answers to the research questions obtained from this study, several recommendations can be made. The learning environment observed in this study was complex. The participants were continually faced by the need to learn two major subjects simultaneously. I observed the effort the students exerted to learn to understand and use the features of hypermedia documents and the technology skills needed to use such documents. At

the same time, the students were equally challenged to learn the complex concepts needed to understand how the present culture of their country evolved.

The hypermedia learning environment placed a high demand on students. Teachers and administration involved with the USC course of studies have acknowledged this fact. A traditional course covering similar content would be given 30 credit hours. The USC credit structure provides 35 credit hours to students for the same amount of class time. In my opinion, the students demonstrated that the extra credits were earned, and not a gift. While a hypermedia learning environment did not lighten the demands on students, this particular group of students indicated that since their motivation level was easy to maintain, learning was more enjoyable.

The hypermedia learning environment was not provided to students without considerable effort from the teachers involved. The planning required to create suitable assignments takes more effort than composing a traditional task. Part of this is the result of lack of experience on the part of the teachers. In addition, the teachers needed to learn new methods to cope with the organization of having students use hypermedia tools. For example, it took time to keep track of what topics students had selected to research and ensuring the approach taken by each student would help accomplish the goals. A traditional writing assignment would have been less work to organize and monitor. To assign each student a particular topic and ask each student to produce a ten page essay would have taken far less effort.

It required careful thought from teachers to integrate the use of hypermedia tools into the program. The three teachers were already learning the requirements of working as a team to present an integrated, interdisciplinary program. In addition, the teachers spent considerable time working the hypermedia based learning into the framework of the course. Teachers freely admitted that they felt they were putting in much more time and effort than they had in previous years. They also commented that what they observed in student development was

also much greater. Since they felt students were gaining a great deal from this technology based approach, they felt the time and effort expended was worthwhile.

I feel that is important that teachers recognize the complexity of a hypermedia learning environment. Teachers must realize that the learning doesn't just happen. Teachers must be aware that the use a hypermedia learning environment requires the same careful planning and monitoring that is required in any effective teaching. In the literature review it was suggested that hypermedia is most effective if used in conjunction with other learning methods. The teachers in this setting have done an excellent job of using hypermedia to augment but not replace other effective teaching approaches. I feel the teacher should select their teaching tools based on which tool is most effective for the task.

The literature review indicated that hypermedia tools are effective in learning information in complex or ill-structured domains. The teachers of the USC course of studies have very effectively used this approach. Much of the factual detail and basic information is given to students using more traditional approaches. The hypermedia learning environment provides a tool to learn the concepts that are integrated and formed by associating the basic knowledge. I am of the opinion that the students have developed a method for learning complex concepts that is being used in situations other than the USC classroom. I have observed students during informal study sessions on chemistry and mathematics topics that support this opinion.

I feel that the hypermedia learning environment has given teachers some benefits that indirectly makes their job easier. Students display considerable motivation to learn when working in the hypermedia environment. The teachers shared their view that students working in the section of the USC program not using hypermedia do not display this same level of motivation. These students seem to require much more encouragement from teachers to produce work of a similar quality and need to be constantly reminded to work without creating any interference to others. As an assistant in the lab, I seldom had to remind students to attend to their work. I was able to commend students for helping a classmate achieve their objective

rather than having to reprimand them for creating a distraction. This allows a rapport with students to develop that is not influenced by constant demand from the teacher to focus on the work. The working relationship between teachers and students and between students and students benefits in the hypermedia environment.

Teacher Guidance and Assignment Design

Teachers and students in the study perceived that without instruction and guidance for students in the hypermedia environment, the learning process would not function particularly effectively. Although students preferred assignments that provided some direction, the freedom that hypermedia documents provided in actually completing the work kept each student challenged at a personal level. When I first considered what a hypermedia learning environment could provide, I saw hypermedia as a means of providing self-directional learning for students. I was only partly correct in this assumption. The students strongly recommended that the combination of individual responsibility and guidance provides the opportunity for each student to make maximum progress in the course. I concur.

The design of hypermedia documents is flexible enough to accommodate individual learning preferences. However, I did observe that instructors could easily infringe on this ability. Giving students a tool that could be used effectively in many different ways and then providing tasks that limit the approach to what is learned, seemed a contradiction. I recognize, as did students and teachers, that the most effective way to use hypermedia has not been established. Some of the ideas tried in this situation were better than others. Sometimes instructors imposed too much structure. Sometimes students interpreted assignments too rigidly. Students and teachers acknowledged a need for adjustments by both groups.

Student and Teacher Roles Redefine

Learning in a hypermedia environment produced some changes in the role of student and teacher. I anticipate these changes being much more difficult for teacher than students. The use of a hypermedia learning environment provides students with a feeling of empowerment. One person cannot possibly gain the depth of knowledge on every topic studied that an individual focused on one topic can achieve. The teacher had to learn to acknowledge the student that had done the research could provide the in depth information if it was required. The student becomes the teacher for this particular topic.

In the USC course of studies, the activities students are given encourage an involvement level unusual for students in traditional school settings. In many of these activities, the student is given the opportunity to express their own understanding and perceptions of a concept. In most such presentations, the teacher is still viewed by the class as the authority on the subject. Any dissension which arises is settled by the instructor based on the instructor's perception of the situation.

In the hypermedia environment, the teacher is not always viewed as the authority or the person with the best knowledge level. This is particularly true in regard to issues involving the technology itself. Many students are perceived to be equal or better than the instructor in solving certain technical problems. In the areas of history and literature understanding, on subjects researched for stack authoring students often retain the power inherent in having the greatest amount of knowledge on the topic. For a teacher to step aside and defer to the students' expertise is definitely contrary to the traditional role teachers have assumed.

The role of being an expert in a subject is not restricted to the classroom setting. Students have indicated that their understanding and expertise is being shared outside of school. The problem solving skills that are displayed by students in the Macintosh lab have been applied in similar situations at work or at home. Movies that are attended by students that relate to a topic they have studied in-depth have provided a level of discussion with family or

friends where the student's knowledge level was acknowledge to surpass that of others in the group. I realize that the potential for similar expertise exists in other settings. In hypermedia settings not only does the potential exist but many students demonstrate that they achieve this potential.

A high tech learning environment can change traditional student and teacher role modes. Traditionally, teachers are the authority, in part, because they have experienced life longer. This doesn't hold true for technology skills. Student knowledge of the technology usually develops much faster than the teachers'. Students have little difficulty with this fact. For them, sharing the skills they have learned with their classmates and instructors seems natural. Many students display a growth in self-confidence resulting from the power of recognizing and sharing their expertise. Many teachers feel threatened by this reversal of roles.

It is my opinion that the extent of the empowerment provided by the exchange of roles that hypermedia learning promotes is of benefit to students. This role change was observed during the first week of the study and continued to its completion. I feel that for teachers considering using hypermedia tools in their own classrooms, accepting this phenomena is absolutely essential. This doesn't happen as a result of careful teacher planning. It happens as a natural outcome of the environment created by hypermedia learning tools. To receive the full benefit of using hypermedia learning tools the teacher must be willing to accept this reversal of the traditional roles of students and teachers.

Communication Skills—Text, Images, and Sound

This study has shown me the need to accept that formal communication includes many more elements than I had previously realized. For the participants of this study, the hypermedia documents represented the first time that graphics, sound, and text were considered a single, accepted communication format in school. Learning to use the integrated media occurred on a trial and error basis for most of the group. The students shared their

insight that teaching themselves was beneficial although time consuming. However, for something as complex as the communication system made available in this hypermedia environment, more assistance for students would have been appropriate.

When I investigated the process of how graphics were selected for use in the term project stacks, a major limitation of teacher knowledge was identified. The lab teacher began learning formal visual communication the preceding year. The teacher had sought assistance from people with some expertise on design issues and visual communication. However, for the most part the lab instructor learned by trial and error. While I recognize a tremendous growth in the teacher's awareness of effective communication with images, the ideas they have learned are still unverbalized. The decisions made by the lab instructor are frequently correct but the explanation behind the decision is lacking. This limits what can be taught to the students.

For example, one of the requirements for the term project stack was to include graphics. The students recognized that their selection process was done by borrowing directly from others. The group tended to select graphics by looking in the books used to research their topics. The author of the book had already used a selection process that sorted the pictures available and selected the ones included. Students were choosing from a set of graphics that had already met some criteria. Many students expressed the desire to know what the criteria actually were. Since the teachers did not know this component of visual communication, the teachers could not provide the instruction.

This same situation was encountered when students were trying to learn the use of sound. Sound and pictures are perceived as very natural forms of communication and are readily accepted by the group as valuable enhancements to communicating their ideas. Student communication in conversational settings is effective and efficient. Verbalizing ideas is comfortable for students and so is learning new ideas using auditory input. Students gain quantities of information each day through visual means. However, for formal communications the students experience had been limited to textual communication. The

knowledge needed to use sound, graphics, animation, and movies to the best advantage must still be learned. The instructors in the USC program have only limited knowledge to share.

I am convinced that for a hypermedia learning environment to be used to maximum effect, teachers will need to broaden their understanding of communication skills. I often suggest to educators learning to use *HyperCard* that reading information on desktop publishing will provide a start in gaining the skills. Photography and journalism articles also provide helpful information. However, formal classes for instructors would save a great deal of time and ensure better quality of instruction. The use of sound, pictures, and text as an integrated communication system is natural. What is not natural is placing the pieces together in a limited screen space to be used in an electronic form. Teachers and students are going to need assistance to develop the skills required to complete the process effectively.

Limitations of the Study

In qualitative research, a major limitation of the results is the restricted ability to generalize beyond the group studied. The particular group studied provided considerable data. However, there is no way to know how much of what is presented is unique to the group and how much is generally applicable. The results of the study would be more useful had they been obtained from a number of similar groups. However, much of what was heard from students about the hypermedia environment can be confirmed by comments heard from students in the USC program from the preceding year.

The answers on student questionnaires must be recognized as being vulnerable to error. The questionnaires completed in September illustrate this problem. Several students did not provide an answer to several of the questions. The reasons students skipped the questions is not known. Since the timing of this questionnaire was very early in the year, students had not developed any commitment towards the program's success or towards the researcher's intention. The lack of answers may reflect a lack of interest rather than the lack of opinion.

The answers given on the questionnaires may reflect errors caused simply because the time of day used to complete the questionnaire was not conducive to sustained concentration. Because of the demands on instructional time, the entire group of students could not be made available to complete the questionnaire at one time. One group completed it during third period while the second group used fourth period for the task. For the group writing during third period, the January questionnaire was completed just prior to writing a history exam. For some, the thoughts of the upcoming exam may have distracted them from the questions presented.

The second group completed the task immediately after writing the history exam. They had just spent a full hour exerting maximum mental effort and some commented on feeling mentally tired. Being enthusiastic about completing a questionnaire that had no direct bearing on their success in the USC program was not a priority. In addition, the fourth period immediately precedes the lunch break. Student attention is always more difficult to maintain just prior to lunch. However, using the questionnaires as a basis, all the data presented has been cross referenced to provide confirmation from other sources.

Another component that may have influenced the results of the study is the nature of the group entity. The class taking part in the research study showed considerable difference from the class enrolled in the program during the previous school year. The general attitude of the present group was less focused and students appeared to be less academically oriented. In the hypermedia environment major differences were noted. The present students attempted fewer extra features in their stacks and consequently learned much less programming than the students in the program last year.

An explanation for the differences is difficult to identify. The difference in computer background does not provide an explanation since the present group indicated having greater computer experience than last year's group. Few of the previous group had any computer experience when they arrived in the program. A partial explanation may be found in the academic goals held by members of the two groups. The present group of students have not

identified an intended career goal nor spent much time considering what might be required to achieve a particular career. Last year's students were very aware of what careers they hoped to pursue and constantly worked towards that goal.

Student perceptions are influenced in part by peer pressure. The students in the present study exhibited a strong need to be accepted by the others and were unlikely to take a position in opposition to the majority of students. Although last year's students were very supportive of each other, as individuals they showed the strength to make their own decisions and form their own opinions regardless of what the group feeling might be. The possibility that data is biased towards expressing what students felt was an acceptable opinion rather than their personal belief does exist.

The data obtained through this study reveals that many of the students think at a relatively shallow level. This lack of critical thinking was shown, not only on questionnaires, but also on the notes taken while browsing, during discussions in literature and history class, and the general approach to the course itself. By comparison, last year's group exhibited a much more focused and inquisitive approach to learning. Had the participants in the present study made an effort to analyze the issues at a greater depth, further insights on the issue of using hypermedia might have been shared.

A major limitation in this study stems from the technical setup of the Macintosh lab. For the early part of the study, there were only minor difficulties in using the network as configured for a group of this size. However, data since mid December may be reflecting the increasing problems encountered in a less than desirable network situation. A number of hardware problems were identified and corrected. A number of software conflicts were isolated and corrected. But, the lab increasingly provided service that was less and less reliable.

The problems encountered with the hardware and software, had undoubtedly biased the perceptions students expressed. The problems do add some strength to the conclusions that were drawn. The students involved in the research study have clearly determined in their own

mind that the hypermedia environment has been valuable in their success. Difficulties of a technical nature will continue to be a reality in educational settings. In a situation where no problems occurred, one might be tempted to conclude the data was misleading and not possible to obtain in the average school setting.

Discussion of Japanese Immersion School Versus USC Use of Hypermedia

I have become increasingly aware of some limitations to the hypermedia environment provided for the students in the USC course of studies. The USC students are using ACCESS which provides considerable structure to the authoring process. Students are not required to learn HyperTalk, the programming language that is used by *HyperCard*. The built-in features of ACCESS can give students a document of high quality without specifically requiring any skill in using HyperTalk. However, perhaps this hypermedia tool is of less value to students than would at first appear to be the case.

ACCESS is a research tool and available only to students involved in the research study presently undertaken by the team headed by Kathy Spoehr of the Cognitive Science and Linguistic Department of Brown University. Once the students complete the USC course of studies, the tool is no longer available for their use. Since ACCESS is not a commercial product, the students cannot purchase a copy and continue to produce stacks to fulfill requirements for future courses. The students could gain access to *HyperCard* if they wished but the skills gained in the USC program are not *HyperCard* per se.

The *HyperCard* program uses a special programming language called HyperTalk. Working directly in *HyperCard*, all the objects can be controlled by creating a script in the HyperTalk language. Objects are created by choices in the menu bar or using keyboard shortcuts. In ACCESS, the special authoring tools have eliminated the need for students to learn the corresponding *HyperCard* skills. The few students that have discovered some of the extra power of *HyperCard* such as having fields alternately 'hide' and 'show', are at least

aware of the potential of the scripting language. But, the USC students as a group, could not move easily into the *HyperCard* computer application and create a stack of the quality already achieved in ACCESS.

I have been involved with a second group of students since early January of 1992. These students are members of a Japanese Immersion Elementary School. The fourth grade students began to use *HyperCard* and *HyperStudio* (a program similar to *HyperCard* but created for the Apple IIgs computer) when they started their first hypermedia projects. The Japanese Immersion School, as part of the local Christopher Columbus Consortium (CCC) site, received the loan of a number of Macintosh computers from Apple Computer. As a result, the entire group switched to *HyperCard*. Instruction in using and producing hypermedia documents has continued with the same students as a major component in their grade five program. The school has increased the number of students using *HyperCard* by including students from third, fourth, and fifth grades.

I first became involved with the Japanese Immersion School program in response to the technology instructor's request to the University of Oregon for assistance for herself and her students. Although the instructor had completed a course on *HyperCard* and HyperTalk, she had not attempted to teach the skills she had learned. The instructor knew less about the *HyperStudio* program being used with the Apple IIgs computers. To ensure that students were being given the assistance they desired, I began spending two afternoons a week helping in the classroom.

Instruction was provided on a number of levels. In addition to helping students learn HyperTalk and *HyperCard*, I assisted them in understanding what hypermedia was and understanding the technology that provided the ability to use hypermedia. Students and instructor needed help to learn to use such devices as the scanner, digital camera, videodisc player, and MacRecorder. Information on card and stack design was shared. Assistance was provided in helping students develop the skills needed to work in collaborative group settings.

In other words, the skills I added to the Japanese Immersion School were similar to the skills needed to assist the USC course of studies.

The USC and Japanese Immersion School programs have many features in common. The programs are primarily interdisciplinary in nature. The entire Japanese Immersion School is organized around a thematic curriculum that is followed by the entire school. The USC program endeavors to present the study of Unites States Culture as a single entity. Both groups of students use hypermedia learning tools in a similar fashion. Stacks are available for student browsing as they learn new concepts. While the available stacks for the younger students are more limited, new resource material is constantly being added. Both groups are expected to create their own hypermedia documents. Both groups have the choice of working individually or as a group for many of the stack assignments.

The instruction methods used and assignment requirements are also similar. Students start by creating an outline of the topic, producing a set of index cards as a stack prototype, and draw a schematic stack map. The students in both settings use a combination of text, graphics, and sound to present their ideas. Similar tools are used to include these resources. For both groups, the opportunity to earn bonus points is possible if the student chooses to go beyond the basic requirements of the assignment. In both groups, authors share their work with other members of the class and receive feedback intended to help improve the stacks. Student expertise is shared and the teacher is not automatically the source of assistance.

In May of 1992, the USC students and the grade 4 students from the Japanese Immersion school were brought together for a day of sharing and enjoyment in hypermedia learning. With one exception, groups consisting of two students from each program were formed and produced a short animation stack in approximately three hours. The stacks were done in *HyperCard* rather than ACCESS, but the USC students in the 1991-1992 school year had used *HyperCard* up until January. When the day's events were discussed by each group in their own schools, every single student indicated that they had learned at least one thing from

the other members of their group. Every single student indicated that they had been able to teach at least one thing to the others in the group.

In December of 1992, I examined a number of stacks produced by students at the elementary school setting. The level of scripting used by these students has changed considerably since the first stacks done a year earlier. Scripting has become much more complex and features included in the stacks are subsequently more difficult to achieve. The elementary students have created animation that is equally complex to the work done by the high school students. The elementary students show an increasing awareness of design issues. Design choices made at this level lack the sophistication of the mature student, but begin to illustrate an understanding of communication via hypermedia presentations.

I serve as a lab assistant in both schools. The thought processes reflected by the questions the elementary school students ask me show considerable understanding of computer technology and the *HyperCard* program. Questions from students in the elementary program challenge my own skills in using HyperTalk and *HyperCard* to a greater extent than the questions asked by students in the high school group. Students in the elementary school program have moved to a level where their approach is basically: "This is what I would like to do. How can I do it?" Students in the high school program show a different approach: "This is what I would like to do. Can it be done?"

The USC course of studies provides students with an opportunity to learn in a manner seldom given students in traditional settings. The integrated, hypermedia based learning that is included as part of the curriculum has provided the students with skills that are unusual. Yet, looking just at the technology skills being gained, these students have been given quite a narrow experience. Perhaps combining ACCESS and *HyperCard* instruction would provide a more useful set of skills.

To carry many of the skills into other situations, the USC students will need to take steps to overcome the limitations in their HyperTalk and *HyperCard* understanding. I have no doubt that this option is within reach of the entire group, but how many will find the time and

opportunity to do so is an unknown. The elementary students have skills that can be used throughout their entire school career and for some, beyond. The USC students will need to relearn a number of steps and be introduced to a great deal more information before they have the same flexibility.

Teacher Commitment to Hypermedia as a Learning Tool

The influence of the teacher's attitudes towards the hypermedia learning environment was not studied in the present research. This factor may be critical to the formulation of student perceptions regarding the effectiveness of hypermedia learning tools. The manner in which the hypermedia resources are integrated into the program reflects, to some degree, the perceived value of the tool from the teachers' perspective. This factor may be partly responsible for the results of the present study.

I conducted a formal evaluation of the USC course of studies in the spring of 1992. Teachers were questioned extensively about their decision to include hypermedia learning tools. At this time, the three teachers were somewhat unsure why their program was using hypermedia. The commitment expressed by the teachers was to the contract that had been signed with Brown University. In this contract, the teachers and students were obligated to use ACCESS. Little personal commitment to hypermedia learning tools was expressed by the teachers.

In the present study, informal feedback from teachers provided a very different conclusion. The same teachers are responsible for the literature and lab components of the program while a new staff member provides the history instruction. These three teachers all stated without hesitation that hypermedia provided their program with a number of desired qualities. Hypermedia tools allowed group learning and provided the opportunity to increase technology skills. Hypermedia tools gave students the means to communicate effectively and provided a model of integration that was instrumental to the curriculum. Hypermedia tools

allowed self-directed learning to a great extent and a wide variety of student learning styles could be accommodated.

The teachers identified other factors of value. Learning with hypermedia tools provided ample opportunity for students to experience a feeling of positive self-esteem and self-confidence. Learning with hypermedia tools demanded that students develop and use critical thinking and problem solving skills. These benefits are in addition to the convenience the electronic format of resources provides for learning the concepts included in the course. Teachers displayed a strong personal commitment to the use of hypermedia.

The teachers' attitude towards hypermedia learning tools as used in the USC course of studies is very positive. Each teacher was asked what their reaction would be if Brown University decided to remove the ACCESS resources from the USC program. Each teacher had an immediate solution to this problem. Each teacher would find a way continue to provide this resource to their students. Commercial products would be purchased. *HyperCard* would be used directly so students could experience the authoring of this type of assignment. Help would be requested from local university personnel. Teachers would attend workshops and professional training sessions to increase their own knowledge. In one way or another, the means would be found to continue providing an effective hypermedia learning environment.

The formal evaluation of the USC program done last spring has helped to change the structure of the present program. Although the USC program was intended to be an integrated, interdisciplinary program, this was not achieved last year to the extent that the teachers desired. The actual amount of integration being done last year was considerably less than intended and much less than what teachers thought was being accomplished. In last year's program, the computer component served a subservient role to the literature and history classes. Students did not perceive the three components as working with a single goal in mind.

This year, each of the three course components serve the same goal—the teaching of United States Culture. As teachers changed their own perspective of what hypermedia tools offered, they also changed the way in which the hypermedia resources were being used. The

program is less and less three courses in one and becomes more and more a single course. While each component maintains a unique position in the program, hypermedia is helping to integrate the three components. The three teachers sometimes share the responsibility of evaluating student work and try to monitor the work on term projects as a team. The teachers indicate that they feel further work is needed to make the program truly integrated. However, this year the teachers express the feeling that hypermedia is included because it enhances the learning environment, not because a contract says they must do so.

Teachers are frequently unaware of the extent of their influence over students' attitudes and feelings. Even when not overtly discussed, students become conscious of many teacher attitudes. In some situations, teachers use this influence as part of their teaching style. The study of a novel that is the teacher's favorite is accomplished in a different manner to the study of a novel because it is in the curriculum and must be included. The extent to which teacher attitude influences the effectiveness of hypermedia learning has not been addressed.

One is reluctant to consider what might occur in a situation where teachers are required rather than allowed to choose to use hypermedia. However, as a research topic, this could shed further light on effective versus ineffective teaching with hypermedia tools. Teachers in the USC course of studies are developing on a trial and error basis the methods they require for using hypermedia tools. The step-by-step guidance that would help teachers make the best use of hypermedia tools is not available. A formal study of teacher attitude towards hypermedia and some comparison of the results of different teaching methods would be a useful addition to the field.

Personality of Students Affects the Students Perception of Hypermedia Learning

Over the last few months, I have been closely involved with the students taking the USC course of studies. I have had the opportunity to closely observe and interact with each student on an individual basis and a group basis. The manner in which each student has dealt

with the challenges has been unique. The present study was not designed to delve into the details of each individual's experience with the hypermedia learning environment. However, I realize that such a study could provide some useful insights.

I feel that the effectiveness of hypermedia learning may be in part the direct result of personality traits. For individuals who like to take chances and explore without direction, the task of browsing a stack should have a very different connotation than for less adventurous students. Authoring may not be perceived as the same job by any two students. Would students that see themselves as being creative learn faster than those who do not see themselves as creative? Do students that have always found their writing skills to be more than adequate to fulfill class requirements resent having to cope with an entirely new manner of communication?

The social maturity level and personality of the students in the USC program varies greatly. How much influence does this have on the effectiveness of student learning with hypermedia tools? Students have indicated that they perceive the products produced in ACCESS to be much more public than traditional writing assignments. For a shy person, the unsolicited attention may detract from the value of the learning tool. Every learning method used will be perceived differently by each student. How can teachers minimize the problems that personality traits induce? Students felt that hypermedia was appropriate for use with many different learning styles. Does it meet this need more effectively than traditional methods? What guidelines might be suggested to maximize the ability to have many different learning styles benefit from hypermedia?

Different aspects of hypermedia authoring have been responsible for getting the attention of different students. A large group at the beginning became totally involved primarily because of the novelty and the fascination with the technology. Others displayed this interest level only after the introduction to using graphics in the communication. The last few students to show a keen interest in the work began to display considerable initiative in their work after they became intrigued by the use of sound. Could one use a personality profile to

establish a more effective presentation method so that all students accepted hypermedia learning from the introductory stages? Is there a way to maximize the impact of each resource and increase the motivation through appealing to personality traits?

This type of research would need to be undertaken by someone having both a psychology and an educational background. Identifying personality profiles and assessing the effectiveness of the learning that occurs is well beyond the scope of this study. However, answers to these questions would be valuable in understanding how to make hypermedia an effective tool for everyone.

Authoring as a Way to Teach Students to Read Stacks

A great deal of discussion by the instructors of the USC course of studies revolved around the idea that students needed to be taught how to read an ACCESS stack. The format of hypermedia documents may or may not differ greatly from the tradition, linear approach of printed books. The teachers were concerned that students would need assistance in transferring their skills with printed documents into the electronic presentation. Certainly, until students gain a concept of what hypermedia documents attempt to accomplish and gain skills with the document interface, the learning process is slowed by the hypermedia environment.

The teachers did not develop any particular steps that would be followed rigidly to help students make the transition. A physical prototype of a stack was modeled for students. The concept of electronic links was shared. The special ACCESS icons were explained. The learning process was supported by the instruction on producing and using concept maps to explain ideas and illustrate the associations in the ideas. But, students were left to adjust to the remainder of the elements of reading hypermedia documents on their own. Guidelines are not available, so teachers have coped with the challenge as well as possible.

This study revealed that until students were given some experience in the authoring of hypermedia documents, much of the instruction on using an ACCESS stack was apparently

misunderstood or had no meaning at all. The significance of having a common key word on buttons, card names, and headings used in strands escaped the students totally until they began to make their own stacks. Yet, this simple device provides a major aid in navigating within a hypermedia document and keeping the reader oriented in the content.

I suggest that a study that compares the time required to become competent readers of hypermedia documents in an authoring versus non-authoring environment would be useful. It may be possible to speed up the process of adjustment to hypermedia presentations by introducing the material in a different order. In the USC setting, students could be taught authoring skills prior to using any of the resource stacks. Would this be a more effective use of instructional time?

Further, a study that compared the merits of authoring hypermedia documents versus the merits of using completed hypermedia documents would be valuable to teachers. My personal observations suggest that the experience of authoring teaches students a great deal more about a given topic than does browsing another person's work. Yet, some of perceived value in authoring originates in the fact that students see the product as something which will be shared. The authoring process in hypermedia is intrinsically linked to maintaining a concept of reader audience. The literature review suggested that a hypermedia document is completed only by the actions of authors and readers. Trying to provide only one of the two activities may be unrealistic and inappropriate to the use of hypermedia learning tools.

Learning Associations With Hypermedia Tools Versus No Hypermedia

The school used for my research presents a situation that would produce another useful study. The USC course of studies exists in two distinct formats. I chose to focus on the morning section which uses a hypermedia learning environment. The afternoon section attempts to meet similar goals with an integrated, interdisciplinary approach, but the students

do not use a hypermedia learning environment. A study which compared the quality and quantity of learning that occurred in the two environments would be helpful.

The teachers providing the literature and history instruction in the morning section of the USC course of studies also provide the instruction for the afternoon section. Their informal feedback indicates that the two groups produce very different learning situations. The students using hypermedia began to work as a cohesive group in three months. The class had developed the mechanics to operate at an efficient level with minimal control from instructors to maintain discipline. The afternoon session took twice as long to develop a similar level of group responsibility. This means that the teachers needed to spend many more classes establishing the rules and guiding the students into working as a unit. The time taken for these activities subtracts from the time available for teaching other things.

Both sections are interdisciplinary programs covering approximately the same content. Different novels are selected for each section and the expectations from the afternoon students are slightly less demanding. However, this unique setting could provide data that would help determine if using hypermedia learning tools speeds up a students ability to associate concepts.

From the teachers' perspective, to include the hypermedia learning in both sections of the program would seem to be justified. This conclusion is based partly on the extent to which students in the morning section become involved in the program and learn to be supportive of each other. In addition, the group using the technology responds much more willingly to the challenges of the program and the demands placed on them. Teachers commented that the morning group developed the social skills involved in group work and displayed an increased self confidence sooner and to a greater extent than the afternoon students.

Some school administrative support has been demonstrated for this idea. School administrators have indicated the desire to have all juniors involved in the completely integrated program. Many students have expressed a negative view of this idea. Students felt that if every section included the hypermedia learning environment, the freedom of choice

presently available is lost. Having the option was perceived by students to be as valuable as the benefits of using hypermedia documents. From my own perspective, I can only make the suggestion that a formal study should be conducted to explore this issue. If the benefits of hypermedia outweigh the benefits of the choice, perhaps the freedom of choice should be removed.

Hypermedia Used in Interdisciplinary Programs Versus Traditional Classes

The present research site combines the strength of a hypermedia learning environment with the strength of an integrated, interdisciplinary curriculum. Both approaches have the potential to help students increase their ability to make connections and associations in the material they learn. In addition, both approaches are suitable for providing instruction on the complex information found in history and literature topics. However, in the present study, the contribution of each approach cannot be isolated.

The ACCESS environment is also used in several schools in the eastern United States. These schools do not use ACCESS with interdisciplinary programs. A very interesting study could focus on the difference in the type of hypermedia documents produced by students in each setting. Some criteria that indicated a quality hypermedia document would be needed. The criteria might include such things as the level of complexity in the stack, the value of the information presented, the quality of the textual, visual, and auditory communication, the use of appropriate design techniques, and the synthesis of the concept presented. It is possible that the data from the ongoing research project that created the ACCESS application will provide the data for a comparison of the environments.

At the moment, there is data available to suggest that the complexity of stacks from the research site I used exceeds the complexity of the stacks being created by students in the other sites. This data was shared in January by Kathy Spoehr, head of the Brown research project. Comments by the instructors during last June's conference of the research personnel also

support this concept. However, the site used for the present site is the only integrated program being used in Brown University's project. Also, students at the site have the advantage of having a block of time to use technology on a daily basis. The complexity may result from more students having more experience and instruction with the technical aspects of stack construction.

I feel that it would be possible to find a research site with a similar program that used a product other than ACCESS. To compare what quality of product is produced in different hypermedia settings could provide useful information to educators. From my observations, I perceive the combination of hypermedia and interdisciplinary program as a very powerful learning environment. Students working in USC course of studies exhibit tremendous personal growth in addition to learning many complex concepts. To determine if the combination of hypermedia and interdisciplinary instruction can achieve significantly higher levels of success would be of considerable value to educators.

Conclusions

The research study has provided a number of insights into the manner in which students function in a hypermedia learning environment. Students accepted a role that was empowering to them as individuals and non-competitive with others in the class. The individual growth demonstrated by each student resulted in part from each student being successful in some unique way and sharing this success with others. The hypermedia learning environment encouraged this informal instruction of peer teaching peer. The teachers did not plan this opportunity into the program. The hypermedia learning tool allowed this to happen.

The students that participated in this study have illustrated that their perception of a hypermedia document was quite different than their perception of a traditional written assignment. Hypermedia documents were viewed as being highly visible to others during their creation. Anyone walking past the computer monitor could see what the student was working

on. Students knew that their stack would be seen by their classmates at the completion of the assignment and perhaps by students taking the USC course of studies in the future. This provided considerable incentive for the document to be of high quality and of value to others. The assignment was not seen as merely a way to succeed in the USC program. Instead, the assignment was seen as a way to demonstrate what had been learned and to share this knowledge with others.

Hypermedia documents involved a complex form of communication. The students gained an insight into the integration of media involved in this type of communication. Learning how to use sound, images, and text information to convey concepts provided skills that are being applied in other settings. Many students felt that their grades in other courses had increased since they put more effort into presenting their assignments more effectively. Their interaction with information in class and elsewhere had improved. They received information with greater efficiency. They shared information with greater effectiveness.

Using a hypermedia learning environment provided the students an opportunity to learn more about technology. Most of the students enjoy working with computers and the novelty of computer technology helped to offset many of the difficulties encountered in the lab. The students gained skills with both hardware and software. The way in which they approached a problem with the technology changed. Their understanding of how the computer dealt with data increased.

Although the number of software applications used was minimal, many students indicated feeling comfortable enough to learn new programs on their own. Several students in the class took the time to work with a three dimensional graphics program and incorporated their work into the ACCESS stacks. Others were able to use a statistical graphing program to complete work for their biology class without receiving any instruction. Many students selected the USC course of studies in order to learn more about computer technology. All students felt that the hypermedia environment had provided the opportunity for them to increase their technical skills.

As an educator, the value of the hypermedia learning environment identified by students is a strong recommendation to use hypermedia tools. The research study identified a need for teachers to develop considerable technical knowledge. The benefits identified by the students should provide sufficient reason for teachers to accept the necessity of gaining the technical skills required. Hypermedia learning tools has added a considerable strength to the program used in this study. There is reason to feel that similar programs would provide the same benefits to students.

APPENDIX A

COMPUTER EXPERIENCE TALLY

USC # :_____ Date: _____

For each piece of software/hardware mentioned below please indicate that you have used this previous to the course by writing 'YES' into the space. If you have not used the item please ignore the space.

Software	Experience	Software	Experience
MacWrite		HyperSound	
Apple Works		HyperCard Audio	
MicroSoft Works		Sound Edit	
MicroSoft Word			
Word Perfect			
Aldus FreeHand		PageMaker	
SuperPaint		QuarkXpress	
MacPaint		PrintShop	
MacDraw		TypeStyler	
MacDraft			
MacVision		HyperCard	
Computer Eyes		ACCESS	
MacImage		Telecommunications	
HyperScan		Lotus 1-2-3	
AppleScan		dBase	
Others (name)		Games	

Hardware	Experience	Hardware	Experience
Scanner		Computer Eyes	
Xap Camera		MacVision	
Video Disk		MacRecorder	
Image Writer		Modem	
Laser Printer		Others (name)	

APPENDIX B

HARLEM RENAISSANCE ASSIGNMENT FOR ACCESS

The Harlem Renaissance ACCESS stack is divided into a section called "About the Harlem Renaissance" and sections on eight different writers. In addition, at the end are six screens on WEB Dubois' The Soul of Black Folk.

You are to look through these and make some decisions on the ones you will read carefully and use to take notes. The requirements for this are that you:

1. Get what you consider valuable information from some of the sections in "About the Harlem Renaissance."
2. Get what you consider valuable information about two writers besides Hurston. This would include reading some of their poems or other excerpts given on the stacks as well as getting information about their lives.
3. Get what you consider valuable information about Hurston.

You make decisions on what information is valuable. You are to write this information in note format, not in sentences and paragraphs.

You will get credit for these notes, you will use some of this information in the writing assignment on the Harlem Renaissance, and you will use some of this information on the test.

It is OK to make mistakes on what you consider valuable information. It is not OK to let someone else make these decisions for you. DO NOT COPY. You are to use the notetaking in the program itself. Print the notes ready for submitting for grading.

APPENDIX C

REQUIREMENTS OF TERM ONE PROJECT—RESEARCH STACK

Evidence of research must include:

1. at least three (3) sources not including encyclopedias, which may also be used
   - MS Word 4 file to be created for bibliography using hanging indent format
   - File can be transferred to stack using Copy and Paste (View)
2. internal references used for quotes, ideas or theories and statistics
   Ex: "they arise no more, we are dead the they stand remote on the horizon..." (Remarque, 1926, 76.)
3. at least three subtopics of major topic, each of which will compose a strand in the stack
   - Each strand to be approximately same length
4. MS Word 4 file containing all text for cards
   - to be edited, spell checked, printed and turned in upon request
   - Choose double spacing and .6 margins all around
   - Tab one time to indent paragraphs
   - Heading to include stack name, USC number(s), author(s)

Stack requirements include:

5. 24 card minimum for single; 34 card minimum for partners
6. at least two links to other stacks (student and/or ACCESS) including complete and correct annotations
7. at least one appropriate scanned image
8. Overview/title card (same thing)
   Map card
   Separate Bibliography card
   Author card
9. Index cards identifying card names, topic buttons, card numbers (2 of 5)

Optional:

10. introductory card
    acknowledgment card
    how to use this stack card
11. an appropriate sound resource
12. animation

ACCESS Research Stack Evaluation

Stack Name:_____ Total Points_____

Student Name(s): _____

Meets stack requirements 1 2 3 4 5 6 7 8 9 10
24/34 cards, min. 2 links to other stacks, correct bib, min. 1 scanned image, complete index cards, separate map, bib, author and overview cards

COMMENTS:

Annotation(s) 2 4 6 8 10 12 14 16 18 20
presence of, informativeness of annotation field material

write contents of one annotation linking to another stack and one annotation from overview card. Include button name:

Annotation to another stack Annotation of one overview card button

Links 1 2 3 4 5 6 7 8 9 10
relevance of links, completeness, quality, return links?

Comments:

Graphics 1 2 3 4 5 6 7 8 9 10
informativeness, technical quality

Comments:

Technical Quality 2 4 6 8 10 12 14 16 18 20
organization, attention to detail, clear navigation

Comments:

Appearance 2 4 6 8 10 12 14 16 18 20
consistency of card/field titles, placement, font size/style

Comments:

Optional features 1 2 3 4 5 6 7 8 9 10
sound resource, introductory card, animation, how to use stack card, acknowledgment card

Contents editing 1 2 3 4 5 6 7 8 9 10
Make corrections to contents rewrite, add/delete, attach original document

Total Points: _____

APPENDIX D

QUESTIONNAIRE: TERM PROJECT RESEARCH STACK

USC # _____

1. What was the one thing you found most rewarding as you created your research stack?

2. What was the one thing you found most frustrating as you created your research stack?

3. List the new skills you learned as you created your research stack.

4. List the skills that you actually knew but had forgotten without realizing it and you need to relearn as you created your research stack.

5. Thinking in terms of the time you used to complete your research stack assignment
   a. what task(s) would you spend less time on if you were to do the job again?

   b. what task(s) would you spend more time on if you were to do the job again?

6. As you consider the way in which you organized your time and approached the steps needed to complete your research stack, what would you do differently if you could do the job over again from start to finish?

7. List specific problems you had as you worked to complete the research stack.

REFERENCES

Alty, J. (1991). Multimedia—what is it and how do we exploit it? In D. Diaper & N. Hammond (Eds.), People and computers VI: Proceedings of the HCI '91 conference (pp. 31-46). Cambridge: Cambridge University Press.

Ambron, S. (1990). Multimedia composition: Is it similar to writing, painting, and composing music? In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 69-84). Redmond, Wash: Microsoft Press.

Azarmsa, R. (1991). Education computing: Principles and applications. Englewood Cliffs, NJ: Educational Technology.

Begeman, M., & Conklin, J. (1988, Oct.). The right tool for the job. Byte, 255-268.

Bernstein, M. (1991). The navigation problem reconsidered. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 285-297). New York: McGraw-Hill.

Bevilacqua, A. (1989). Hypertext: Behind the hype. American libraries, 158-162.

Bielawski, L., & Lewand, R. (1991). Intelligent systems design. New York: John Wiley & Sons.

Bolter, J. (1991). Writing Space. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Bourne, D. (1990). Computer-assisted instruction, learning theory, and hypermedia: an associative linkage. Research strategies, 8(4), 160-171.

Bradsher, M. (1990). The teacher as navigator. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 311-329). Redmond, Wash: Microsoft Press.

Bransford, J., & Stein, B. (1984). The ideal problem solver: A guide for improving thinking, learning, and creativity. New York: W.H. Freeman and Company.

Brinkerhoff, R., Brethower, D. Hluchyj, T., & Nowakowski, J. (1983). Program evaluations: A practitioner's guide for trainers and educators. Boston: Klewer-Nijhoff.

Brown, P. (1991). Hypertext: Dreams and reality. In H. Brown (Ed.), Hypermedia/hypertext (pp. 33-54). New York: Chapman & Hall.

Bush, V. (1945). As we may think. The Atlantic monthly, 176(1), 101-108.

Campbell, R., & Hanlon, P. (1990). *HyperCard*: A new deal in the classroom. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 257-286). Redmond, Wash: Microsoft Press.

Chen, C. (1989). The first emperor of China's ancient world uncovered: From Xian to your electronic screen. Academic computing, 3(7), 10-14, 54-57.

Conklin, J. (1987). Hypertext: An introduction and survey. IEEE Computer, 20(9), 17-41.

Davis, K. (1989a). A new medium for reading and writing. Paper presented at the annual meeting of the conference on College Composition and Communication, Seattle, WA.

Davis, K. (1989b) Toward a hypertext on writing. Paper presented at the annual Computers and Writing conference, Minneapolis, MN.

Delaney, P., & Landow, G. (1991). Hypertext, hypermedia and literary studies: The state of the art. In P. Delaney & G. Landow (Eds.), Hypermedia and literary studies (pp. 3-50). Cambridge, Mass: The MIT Press.

Devlin, J., & Berk, E. (1991). Why hypertext? In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 9-11). New York: McGraw-Hill.

Diaper, D., & Rada, R. (1991). Expertext: Hypersizing expert systems and expertizing hypertext. In H. Brown (Ed.), Hypermedia/hypertext (pp. 125-163). New York: Chapman & Hall.

Dillon, A. (1991). Human factors issues in design of hypermedia interfaces. In H. Brown (Ed.), Hypermedia/hypertext (pp. 93-105). New York: Chapman & Hall.

Feller, H. (1992). Hypertext as part of a bank-oriented expert system shell. In Society for Worldwide Interbank Financial Telecommunication S. C. (Ed.), Intelligent information access (pp. 1-14). New York: Elsevier Science.

Fernlund, P., & Cooper-Shoup, S. (1991). A realistic view of hypermedia in the social studies classroom. Social studies review, 30(3), 66-70.

Florin, F. (1990). Information landscapes. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 27-49). Redmond, Wash: Microsoft Press.

Franklin, C. (1989). Hypertext defined and applied. Online, 13(3), 37-49.

Franklin, C., & Kinnell, S. (1990). Hypertext/Hypermedia in schools: a resource book. Santa Barbara: ABC-CLIO.

Friedman, E., McClellan, J., & Shapiro, A. (1989). Student performance in an electronic text environment. Machine mediated learning, 3(3), 243-258.

Gaines, B. (1990). Intelligent systems as a stage in the evolution of information technology. In Z. Ras & M. Zemankova (Eds.), Intelligent systems: State of the art and future directions (pp. 431-455). New York: Ellis Howard.

Garzotto, F., Paolini, P., Schwabe, D., & Bernstein, M. (1991). Tools for designing hyperdocuments. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 179-208). New York: McGraw-Hill.

Gay, G., & Mazur, J. (1991). Navigating in hypermedia. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 271-283). New York: McGraw-Hill.

Grawbowski, B., & Curtis, R. (1991). Information, instruction, and learning: A hypermedia perspective. Performance improvement quarterly, 4(3), 2-12.

Hammond, N. (1991). Teaching with hypermedia: Problems and prospects. In H. Brown (Ed.), Hypermedia/hypertext (pp. 107-124). New York: Chapman & Hall.

Hartman, D., & Schell, J. (1991). Using hypertext to enhance advanced learning, thinking, and application. Journal of studies in technical careers, 13(1), 47-59.

Havholm, P., & Stewart, L. (1988). Thinking with hypertext. In Proceedings of the National Educational Computing Conference (pp. 356-361). Boston, Mass.

Havholm, P., & Stewart, L. (1990). Modeling the operation of theory. Academic computing, 4(6), 8-12, 46-48.

Hofmeister, J. (1990). The birth of hyperschool. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 199-221). Redmond, Wash: Microsoft Press.

Hofstadter, D. (1985). Godel, Escher, Bach: An eternal golden braid. New York: Vintage Books.

Hooper, K. (1990). *HyperCard*: A key to educational computing. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 5-25). Redmond, Wash: Microsoft Press.

Jenkins, Y. (1990). Multimedia technology: Tools for early learning. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 111-123). Redmond, Wash: Microsoft Press.

Jonassen, D. (1988). Designing structured hypertext, and structuring access to hypertext. Educational technology, 28(11), 13-16.

Jones, A. (1990). To 'criss-cross in every direction'; or why hypermedia works. Academic computing, 4(4), 20-21, 30.

Jones, B., Palinscar, A., Ogle, D., & Carr, E. (Eds.). (1987). Strategic teaching and learning: Cognitive instruction in the content areas. Alexandria: ASCD.

Joyce, M. (1988). Siren shapes: Exploratory and constructive hypertexts. Academic computing, 3(4), 10-14, 37-42.

Joyce, M. (1991). Selfish interaction or subversive texts and the multiple novel. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 79-92). New York: McGraw-Hill.

Koetke, W. (1990). In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 351-356). Redmond, Wash: Microsoft Press.

Landow, G. (1989). Course assignments using hypertext: The example of Intermedia. Journal of research on computing in education, 21(3), 349-364.

Landow, G. (1992). Hypertext: The convergence of contemporary critical theory and technology. Baltimore, Maryland: John Hopkins University Press.

Landow, G., & Delaney, P. (1990). Hypertext, hypermedia and literary studies: The state of the art. In P. Delaney & G. Landow (Eds.), Hypermedia and literary studies (pp. 3-50). Cambridge, Mass: The MIT Press.

Lanza, A., & Roselli, T. (1991). Effects of the hypertextual approach versus the structured approach on students' achievement. Journal of computer-based instruction, 18(2), 200-202.

Layman, J., & Hall, W. (1991). Applications of hypermedia in education. Computers education, 16(1), 113-119.

Lengel, J., & Collins, S. (1990). *HyperCard* in Education: Perspective from the field. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 189-198). Redmond, Wash: Microsoft Press.

Liebhold, M. (1990). Hypermedia and visual literacy. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 99-110). Redmond, Wash: Microsoft Press.

Marchionini, G. (1988). Hypermedia and learning: Freedom and chaos. Educational technology, 28(11), 8-12.

McDaid, J. (1991). Breaking frames: Hyper-mass media. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 445-458). New York: McGraw-Hill.

McKnight, C., Dillon, A., & Richardson, J. (1989). Problems in hyperland? A human factors perspective. Hypermedia, 1(2), 167-178.

Mintz, D. (1990). Launching teachers into a hyperworld. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 155-187). Redmond, Wash: Microsoft Press.

Moulthrop, S. (1991). Toward a paradigm for reading hypertexts: Making nothing happen in hypermedia fiction. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 65-78). New York: McGraw-Hill.

Mukherjee, D., & Phelps, R. (1992). Automating the production route. In Society for Worldwide Interbank Financial Telecommunication S. C. (Ed.), Intelligent information access (pp. 15-28). New York: Elsevier Science.

Nanny, M. (1990). Interactive images for education. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 85-98). Redmond, Wash: Microsoft Press.

Nicol, A. (1990). Children using *HyperCard*. Interactive images for education. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 141-154). Redmond, Wash: Microsoft Press.

Nielsen, J. (1991). Usability considerations in introducing hypertext. In H. Brown (Ed.), Hypermedia/hypertext (pp. 3-13). New York: Chapman & Hall.

Nielsen, J. (1990). Hypertext & hypermedia Boston: Academic Press.

Noblitt, J. (1988). Writing, technology and secondary orality. Academic computing, 2(5), 34-35, 56-57.

Noblitt, J. (1989). Technology and language learning. Academic computing, 4(2), 32-33, 63-64.

Novak, J., & Gowin, D. (1984). Learning how to learn. Cambridge, Mass: Cambridge University Press.

Olivieri, P. (1990). *HyperCard*, technology, and education. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 297-307). Redmond, Wash: Microsoft Press.

Oren, T. (1990). Cognitive load in hypermedia: Designing for the exploratory learner. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 125-139). Redmond, Wash: Microsoft Press.

Osborn, H. (1990). Media computers, motivation, and informal education: Gutenberg 2000. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 357-381). Redmond, Wash: Microsoft Press.

Patton, M. (1990). Qualitative evaluation and research methods (2nd ed.). Newbury Park: Sage Publications.

Perez, E. (1991). Tools for authoring hypertexts. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 209-224). New York: McGraw-Hill.

Picher, O., Berk, E., Devlin, J., & Pugh, K. (1991). Hypermedia. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 23-52). New York: McGraw-Hill.

Rada, R. (1991). Small, medium, and large hypertext. Information processing & management, 27(6), 659-677.

Ramsland, K. (1992). The art of learning. Albany, NY: State University of New York Press.

Schoenfeld, A. (1988). When good teaching leads to bad results: The disaster of 'well-taught' mathematics courses. Educational psychologist, 23(2), 145-166.

Schoenfeld, A. (1989). Explorations of students' mathematical beliefs and behavior. Journal for research in mathematics education, 20(4), 338-355.

Semper, R. (1990). *HyperCard* and education: Reflections on the hyperboom. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 51-67). Redmond, Wash: Microsoft Press.

Shirk, H. (1991). 'Hyper' rhetoric: Reflections on teaching hypertext. The technical writing teacher, 18(3), 189-200.

Shneiderman, B. (1989). Reflections on authoring, editing, and managing hypertexts. In E. Barrett (Ed.), The society of text (pp. 115-131). Cambridge, Mass: The MIT Press.

Shneiderman, B., Kreitzberg, C. & Berk, E. (1991). Editing to structure a reader's experience. In E. Berk & J. Devlin (Eds.), Hypertext/hypermedia handbook (pp. 143-164). New York: McGraw-Hill.

Slatin, J. (1991). Composing hypertext: A discussion for writing teachers. In E. Berk & J. `Devlin (Eds.), Hypertext/hypermedia handbook (pp. 55-64). New York: McGraw-Hill.

Slatta, R. (1991b). Hyperhistory: A new way of seeing and teaching history. Collegiate microcomputer, 9(4), 202-204.

Smith, I. (1992a). Evaluation report: United States Culture Program—Henry D. Sheldon High School. Unpublished manuscript.

Smith, I. (1992b). Research Instrument #2. Evaluation report: United States Culture Program.

Spiro, R., Coulson, R., Feltovich, P., & Anderson, R. (1988). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains. (Report no. 441) Urbana, Illinois: Illinois University, Center for the study of reading. [Ed 302 821].

Spiro, R., Feltovich, P., Jacobson, M., & Coulson, R. (1991a). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. Educational technology, 31(5), 24-33.

Spiro, R., Feltovich, P., Jacobson, M., & Coulson, R. (1991b). Some constructivism issues as they relate to cognitive flexibility theory and hypertext. Educational technology, 31(9), 22-25.

Stanley, A. (1992). Hypertalk and hypertext. Melksham, Wiltshire: Redwood Press.

Stebbins, B. (1990). Using *HyperCard* in apple classrooms of tomorrow. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 223-255). Redmond, Wash: Microsoft Press.

Strauss, A., & Corbin, J. (1990). Basics of qualitative research. Newbury Park: Sage Publications.

Van Dam, A. (1987). Hypertext '87 keynote address. In ACM Hypertext on Hypertext [computer program]. Association for Computing Machinery, 11 W. 42nd St., New York, NY 10036.

Vanio-Larsson, A. (1991). Training within an interactive multimedia environment. In D. Diaper & N. Hammond (Eds.), People and computers VI: Proceedings of the HCI '91 conference (pp. 31-46). Cambridge: Cambridge University Press.

Walker, T. (1990). *HyperCard* and videodisc: A case study in design. In S. Ambron & K. Hooper (Eds.), Learning with interactive multimedia (pp. 331-348). Redmond, Wash: Microsoft Press.

Yankelovich, N. (1991). From electronic books to electronic libraries: Revisiting 'reading and writing the electronic book'. In P. Delaney & G. Landow (Eds.), Hypermedia and literary studies (pp. 133-141). Cambridge, Mass: The MIT Press.

Yankelovich, N., Meyrowitz, N., & van Dam, A. (1991). Reading and writing the electronic book. In P. Delaney & G. Landow (Eds.), Hypermedia and literary studies (pp. 53-79). Cambridge, Mass: The MIT Press.

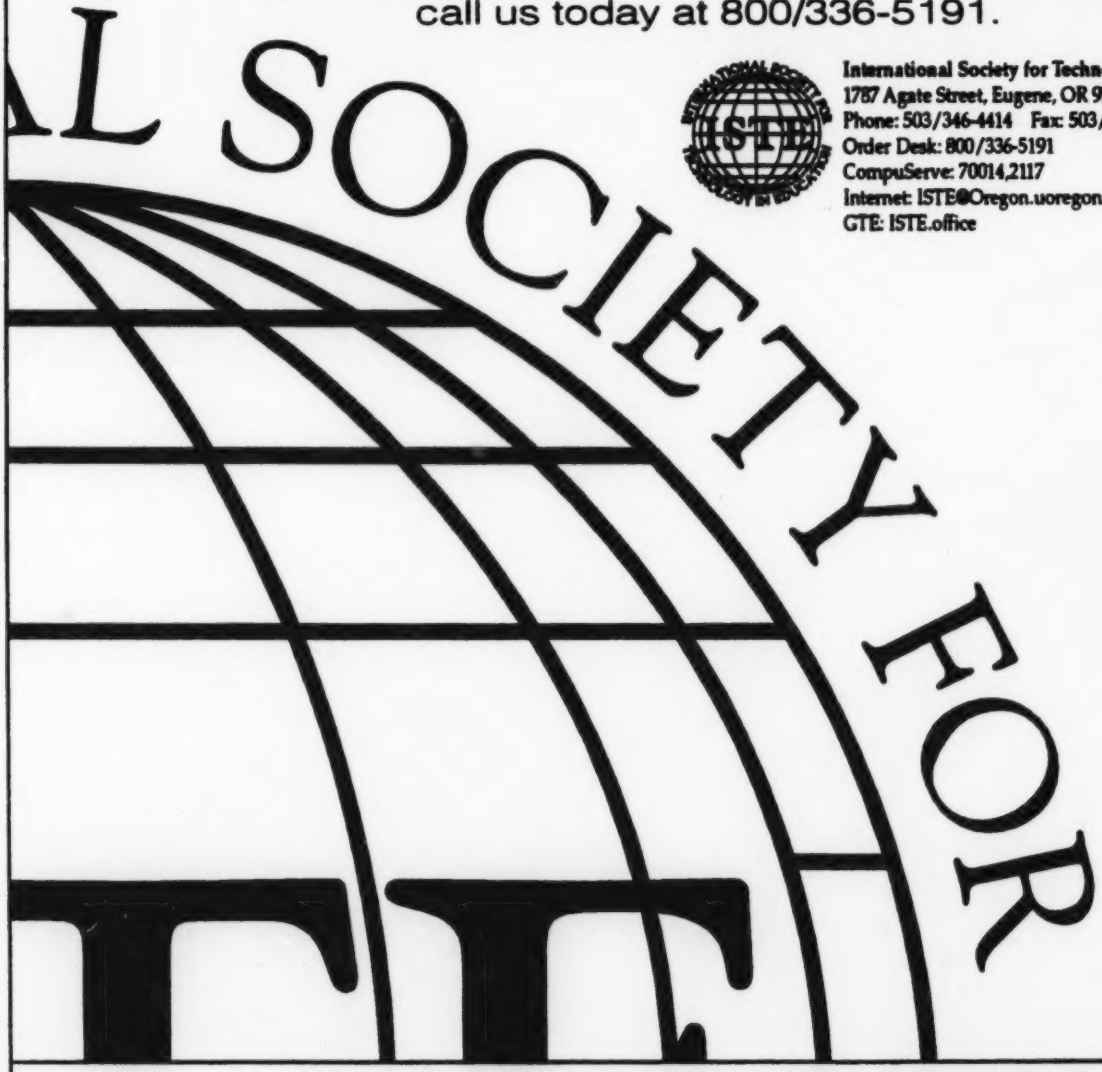
ISTE BRINGS THE WORLD OF TECHNOLOGY CLOSER TO YOU.

By drawing from the resources of committed professionals worldwide, ISTE provides support that helps educators like yourself prepare for the future of education.

ISTE members benefit from the wide variety of publications, specialized courseware, and professional organizations available to them. .

They also can enjoy exciting conferences, global peer networking, and mind-expanding independent study courses.

So if you're interested in the education of tomorrow, call us today at 800/336-5191.



International Society for Technology in Education
1787 Agate Street, Eugene, OR 97403-1923
Phone: 503/346-4414 Fax: 503/346-5890
Order Desk: 800/336-5191
CompuServe: 70014,2117
Internet: ISTE@Oregon.uoregon.edu
GTE: ISTE.office

WE'LL PUT YOU IN TOUCH WITH THE WORLD.

BEST COPY AVAILABLE